SCIENTIFIC AMERICAN SUPPLEMENT No 786

Scientific American Supplement, Vol. XXXI. No. 786.
Scientific American, established 1845.

NEW YORK, JANUARY 24, 1891.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE TEGEL WATER WORKS.

HOWEVER far back we may go in the history of nations, we always find the attempt to provide the populace with water by means of suitable structures. From the earliest times nothing was more evident to man than the necessity of transporting this, the most important of all aliments, without which no life can be sustained. The cities which lay in mountainous regions were generally supplied with clear spring water, as the ruins in the neighborhood of former large cities testify. It was more difficult to supply places situated in plains, after the water which had been obtained from wells proved insufficient for the demand; and never until our time have arrangements been devised by which surface water and the water from lakes and rivers could be purified so as to meet the requirements.

One of the most interesting enterprises of this kind is to be found at Tegel, that little suburb of our capital which is known even to those who are not citizens of Berlin as the birthplace of the Humboldt brothers. The Tegel works, which, with the old Stralau works, supply the necessary water to the city of Berlin through a network of pipes, have been in operation since 1885. Later additions have been made to the original plan.

The method of purifying the water before it is delivered to the consumer is extremely interesting and worthy of description. In the Tegel Lake are placed so-called "suction chambers," which cleanse the water by causing it to pass through sieves that hold back water plants, etc. From here the water is taken up by engines and driven into the filters. Special care is taken in the construction of these, each of them being lined with masonry, so that the surface water cannot enter, and they are protected at the top by arches. They contain a layer of sand, under which is a layer of gravel, and finally there is a layer of coarse pebbles. The water trickles through this mass, leaving all impurities behind it, and then it is collected in a reservoir from which it is sent, under pressure, through pipes nearly a yard in diameter, to the West End, near Charlottenburg. At the high West End there are reservoirs for the reception of the water, and pumps for driving it into the network of pipes in the main part of the city. It would seem strange in our electrical age, if electricity did not play its part here, and, in fact, electrical registering apparatus are used on the elevators at Tegel for indicating the level of the water in the reservoirs at West End.

FIG. 1.—THE TEGEL WATER WORKS—OUTSIDE AND INSIDE OF THE GREAT FILTER.

Experience has shown that filters of this kind will retain their filtering power only for a certain length of time. At Tegel these devices work for about a month, and then the gravel is placed in the so-called "sand-washers" to be cleansed for future use. An idea of the amount of water consumed in the city can be obtained from the fact that the Tegel works alone clarify about 90,000 cubic yards of water every twenty-four hours.—*Illustrirte Zeitung.*

OCEAN WAVES.

THE enormous might and destructiveness of ocean waves, although long well known by "those who go down to the sea in ships," have never been more forcibly brought to the attention of landsmen than during the past winter. The reports of shipmasters engaged in the North Atlantic trade prove conclusively that the winter of 1889–90 was marked by more violent gales and more tremendous seas than any other winter of which we have any record.

It is well known to seamen that about the nastiest open ocean waves in the world are in the Gulf Stream to the southward of the Banks, where the current opposes them when they come from the east. The current seems to make them narrower and steeper. The size of a wave is nothing to a sailor, provided it is broad enough on the base and has sloping instead of steep sides. The largest waves to be found are off the Cape of Good Hope, where, at times, there are not over half a dozen swells to the mile, but they are not at all dangerous compared with such a sea, for instance, as was encountered by the steamer Glamorgan in her passage from Liverpool to Boston a few years ago.

The steamer was noted for her structural strength, but she was boarded during a gale by one wave that tore off her iron bulwarks as if they were made of cardboard, carried away her boats, broke away the whole side of the iron house on deck, tore off hatches, filled the hold, and made her a complete wreck.

The Scythia, in a voyage to Boston last January, made during 24 hours 307 miles by the indicated revolutions of the screw, but, in fact, she made only eighty-six miles ahead, owing to the propeller being almost constantly out of the water while the vessel was riding the enormous seas. In the same gale the Sardinian, from Portland for Liverpool, shipped a sea that tore from its fastenings her heavy iron smokestack, flooded the fire room, and put out the fires, smashed all her boats but one, and killed three men. In the same month the steamship Rhynland, from Antwerp for New York, was boarded by one sea that smashed five of her boats, her wheelhouse, and her port rail. Another sea fell on deck, smashing three more boats, carrying away the rail, breaking the heavy iron turtle-back, and disabling the steering gear. The Italia was struck by a sea that snapped off two blades of her propeller as though they were pipe stems. Half the steamers that crossed the North Atlantic in the past winter had to put into Halifax for a fresh supply of coal, and several were obliged to burn their boats, spars, bulwarks, and even portions of their cargo, to reach port.

Many of them, with their bows pointed to the sea and their powerful engines going at full speed, could not make any headway against the tremendous force of the waves and wind. Many were obliged to put back to Liverpool, as during days and weeks of battling with the waves they could make no headway against them. In several cases the crews refused to do duty unless the captain would put back to port.

Some were actually set back by the elements in spite of their best efforts to drive against them. Others were only saved from foundering by lying to and using oil, and others were overwhelmed in their terrible battle with the awful seas and went down.

Perhaps the influence of the tides on the waves is nowhere more clearly shown than on the coasts of Scotland.

In the long, narrow bays that indent the coast the tides have a very rapid current. No boat can live there in a gale that is running contrary to the tide. There is a theory that the tides are the cause of a very striking peculiarity of the waves in a storm. It has been noticed that after a series of moderately high waves have passed a ship, she will encounter three in succession which are conspicuously large. Then there will be a longer or shorter period of comparatively moderate waves, followed by three more very large ones, and so on. Some sailors believe that tides or currents tripping up the waves bring them together until they unite in those enormous swells that carry havoc on their crests. In support of this is cited a case at Peterhead Harbor, on the English coast. Over thirty years ago there was a great crowd of people down near the beach one day watching the swells come in from the severest storm on record at the time. About two hours before high water three tremendous waves rolled in, and, breaking on the beach, carried away 315 feet of a great bulkhead built nine and a half feet above high water of the spring tides. One piece of the wall weighing thirteen tons was carried fifty feet.

Two hours exactly after high tide three more waves came in of a similar character, but they did less damage.

This was the first case on record in which the formation of the big seas was connected with the time of the tides, but similar observations have been frequent since then.

It is on record that the waves of the German Ocean once broke in two a solid column of freestone thirty-six feet high and seventeen feet in diameter at the base. The diameter at the place of fracture was eleven feet. At the top of the Bound Skerry of Whalsey, in Zetland, the waves have broken out of their beds, which are eighty-five feet above the level of the sea, blocks of stone weighing from eight to ten tons. Smeaton, in his history of the Eddystone Lighthouse, says, in referring to the power of waves, that "controlling these powers of nature is subject to no calculation."

At Port Sonachan, in England, where the "fetch" of the waves, or the breadth of the water over which they travel, is but fourteen miles, a block of stone weighing a fourth of a ton was torn out of a solid stone stairway leading from a landing. It was then rolled over and over. If such effects are obtained under

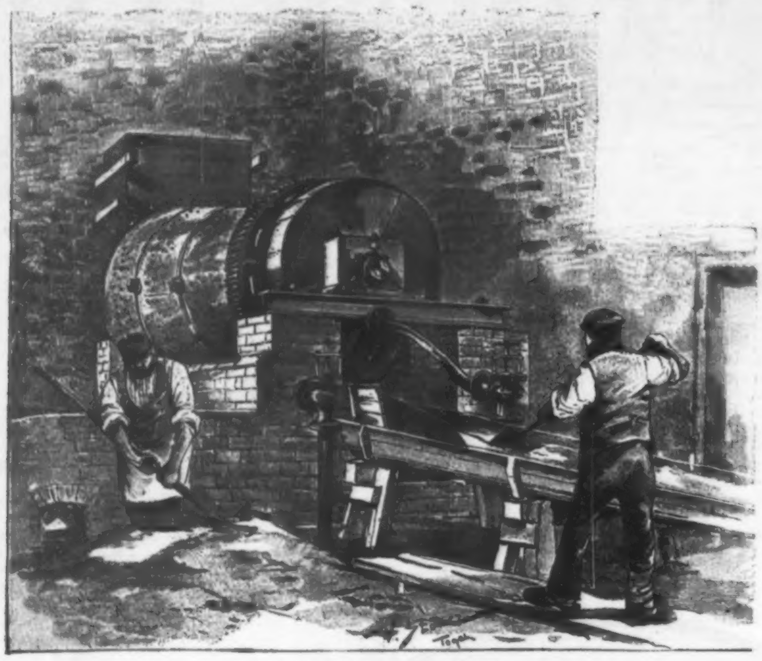


FIG. 2.—SAND WASHER.

FIG. 3.—NEW BOILER ROOM

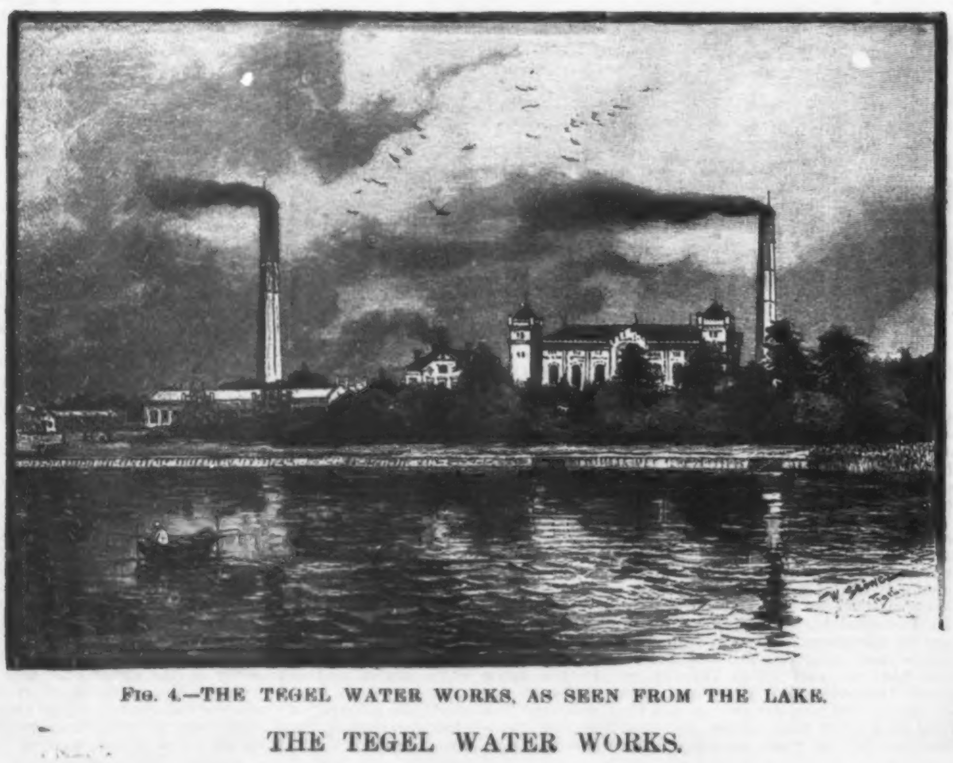


FIG. 4.—THE TEGEL WATER WORKS, AS SEEN FROM THE LAKE.

THE TEGEL WATER WORKS.

such circumstances, what must be the force which Atlantic steamers have to encounter? But for the enormous strength of the modern steamer and the fact that she rarely receives the full impact of the wave, few steamers could hope to withstand the tremendous power of the ocean waves in a gale of wind.

The case is entirely different with sailing vessels. These are lighter, more buoyant, and ride the seas better than steamers. Besides, they are never, of course, forced head to the sea. In violent gales they either scud before the seas or lie to, while the steamer is frequently forced, at a high rate of speed, directly toward the approaching swell.

Although the North Atlantic is noted above every other body of water in the world for its dangerous seas, it has not a complete monopoly in this regard. At Tillamook Rock lighthouse, situated in the Pacific, off the coast of Oregon, a stone weighing eighty-two pounds was thrown by the force of the waves to the top of the lightkeeper's house, 110 feet above the sea level. During the same gale the waves were so high that the water came down the chimney of the boiler house of the fog siren in torrents and poured out through the tubes of the boiler. The chimney is 130 feet above sea level. The spray entered the cowl of the chimney over the lamp, which is about 150 feet above sea level, and ran in streams to the bottom.

Some experiments have been made with a view accurately to measure the force exerted by waves. The instrument is called a marine dynamometer. It has a known surface for the water to impinge on, the force of the impact being transferred to springs of known strength. The distance to which the springs are compressed is self-registering. This instrument has recorded the force of the waves, not under extraordinary circumstances, as high as three tons to the square foot. No doubt, in exceptional cases, the pressure has been more than double that figure.

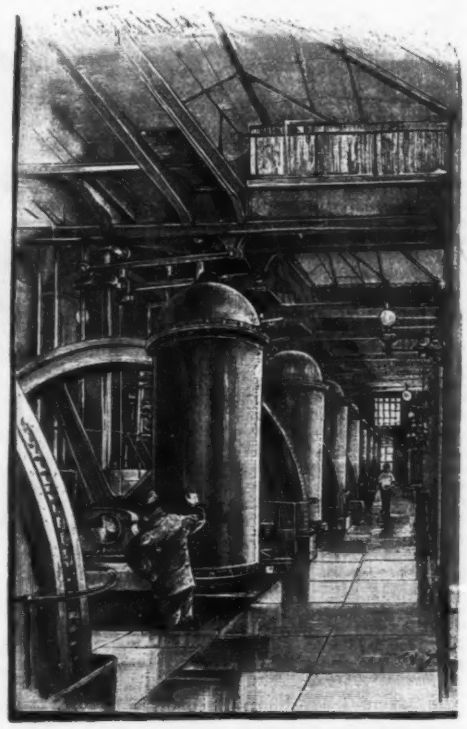


FIG. 5.—NEW ENGINE ROOM.

Any one observing ocean waves cannot fail to be struck with their rapid advance, even when their dimensions are small. A wave 200 feet in length, from hollow to hollow, has a velocity of 19 knots an hour, and such waves are of common occurrence. A wave 400 feet in length has a velocity of 27 knots an hour, and an Atlantic storm wave 600 feet long moves at the speed of 32 knots an hour. In considering the subject of the velocity of waves, it should be borne in mind, however, that in all wave motion it is the wave form which travels at these high speeds, and not the particles of water. This has been satisfactorily proved, both by observation and experiment. If a billet of wood is dropped overboard from a ship, past which waves are traveling at great speed, it is well known that it is not swept away, as it would be on a tideway where the particles of water moved onward, but it simply sways backward and forward as successive waves pass. The velocity of waves is said to depend primarily upon the power and continuance of the wind, but it is greatly modified by, and bears an ascertainable relation to, their magnitude and the depth of water over which they pass. It has been calculated by Airy that a wave 100 feet in breadth, and in water 100 feet deep, travels at the rate of about fifteen miles an hour, one 1,000 feet broad and in water 1,000 feet deep at the rate of forty-eight miles, one 10,000 feet in breadth, and in water 10,000 feet deep, will sweep forward with a velocity of not less than 154 miles an hour.

Bache stated, as one of the effects of an earthquake at Samoda, on the island of Niphon in Japan, that the harbor was first emptied of water, and there came in an enormous wave, which receded and left the harbor dry. This occurred several times. The self-acting tide register at San Francisco, which records the rise of the tide upon cylinders turned by clocks, showed that at that place, 4,800 miles from the scene of the earthquake, the first wave arrived twelve hours and sixteen minutes after it had receded from the harbor of Samoda. Hence it had traveled across the broad bosom of the Pacific ocean at the rate of 6½ miles a minute.

Carefully repeated experiments made by an experienced English navigator at Santander, on the

north coast of Spain, showed the crest of the sea waves in a prolonged and heavy gale of wind to be 42 feet high, and allowing the same for the depth between the waves, the result would be a height of 84 feet from crest to hollow. The distance from crest to crest was found to be 386 feet. Estimates of the waves in the South Atlantic during great storms give a height of 50 feet for the crests and 400 feet for the length. In the North Sea the height of crest seldom exceeds 10 feet, and the length 150 feet. The Compte De Marsili, in his "Physical History of the Sea," says that the highest wave observed by him on the shores of Languedoc, where the fetch across the Mediterranean was 600 miles, was 13½ feet from crest to hollow. No doubt, this height has been exceeded at times, although the Mediterranean is by no means noted for heavy seas. The Gallia, in a voyage to New York last January, was boarded by a sea that her captain estimated was 100 feet high. The captain stated that, had the Gallia been boarded by another such sea, she would have foundered inevitably.

As to the ratio of the heights to the lengths observed in deep sea waves, authorities agree that as the lengths increase, this ratio diminishes, and the wave slope becomes less steep. The shortest waves are the steepest, and the greatest recorded inclinations are for very short waves, when the ratio of height to length was about 1 to 6. For waves from 330 to 350 feet in length the ratio of 1 to 8 has been observed, but these were exceptionally steep waves. For waves of 500 to 600 feet in length it falls to about 1 to 20, and for the longest waves it is said to fall as low as 1 to 50.

It seems probable that in waves of the largest size commonly met the height does not exceed one twentieth of the length, and the highest limit of steepness in waves which are large enough to influence considerably the behavior of ships does not give a ratio of height exceeding 1 to 10. Waves from 500 to 900 feet in length are sometimes encountered having heights of from 5 to 10 feet only.—*N. Y. Sun.*

RETORT WITH CONTINUOUS FEED AND DISCHARGE.

By R. HAIG.

THIS retort, which belongs to the Mechanical Retorts Company, Limited, of Paisley, possesses, apart from its mechanical principle, a feature which should, I think, render it interesting to you from a scientific point of view. I refer to the manner in which it utilizes the heat supplied to it.

A retort, in the ordinary conception of the term, is a vessel usually much longer than broad, and which may have its length disposed in a vertical, inclined or horizontal direction. The cross section may be round, square, ℧-shaped or oval. A furnace heats the outside, and the charge more or less completely occupies the inside. Heat passes by conduction through the shell of the retort to the contents, and upon the texture of these as well as on the temperature of the fire depends in a great measure the rapidity with which the charge is worked off.

The substances distilled are of low conductivity, and if they are charged into the retort in a state of fine division, or if they crumble during the distillation, the heat takes much longer to penetrate to the center of the charge than when, owing to the state of coarser division of the material, there is more interstitial space.

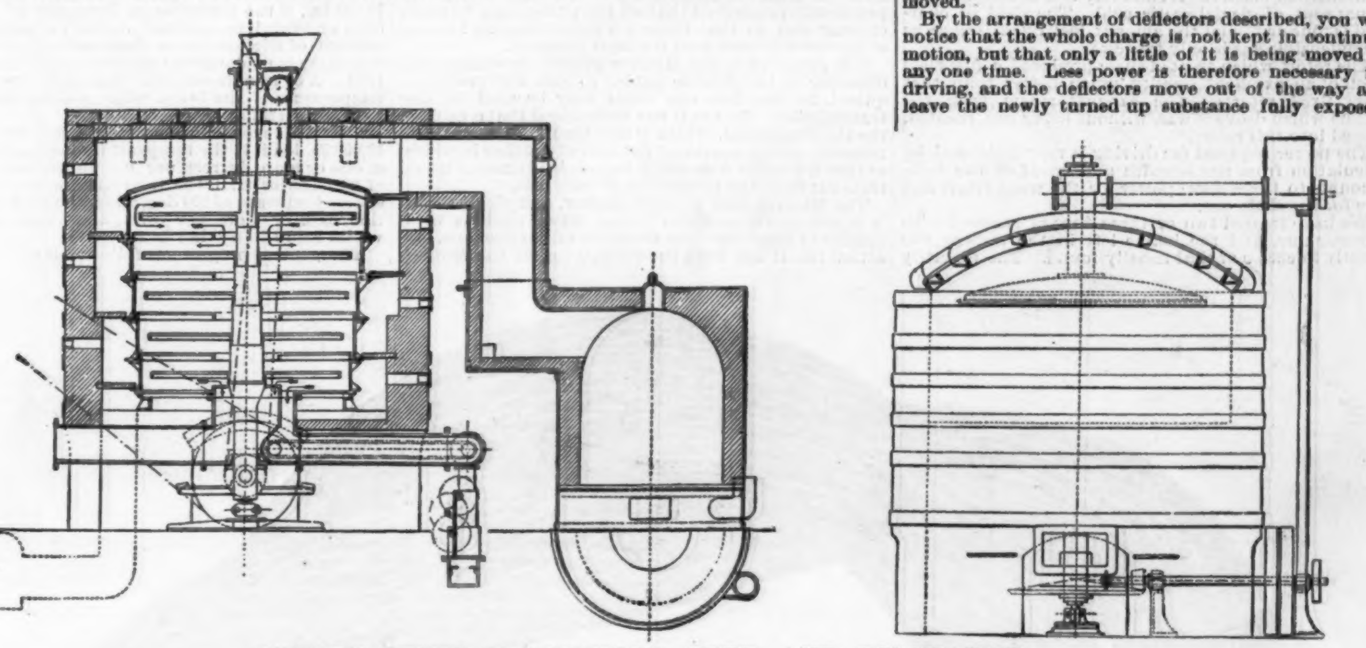
This, I think, is owing to the fact that in the latter case the gases evolved from that portion of the charge adjacent to the hot shell are free to travel throughout the rest of the mass, and by convection distribute the heat they have received. The quantity of heat transmitted by radiation must be very small, and I know of no retort constructed specially to admit of an increase in this quantity. Inventors have centered their efforts on the production of a retort with such a cross section that no part of the charge shall be remote from the shell, and with as large a volume of gas—whether liberated from the material or introduced from outside—passing through the charge as could be conveniently dealt with.

In the retort of which this is a sketch you will see that the order of importance of the three ways by which heat may be transmitted is reversed. The charge is kept as free as possible from contact with the shell and is spread out to receive the heat radiated down upon it from every side. The gases liberated are forced to travel in a certain direction which keeps them also as much as possible from contact with the shell, while at the same time they are made to traverse the insterstices of the material, so that if hotter they impart heat to it, if colder they receive heat from it, and thus help by convection to equalize the temperature throughout, while the continuous renewal of the atmosphere in contact with any given particle of the substance undergoing decomposition greatly assists the removal of the products of heavier density and materially contributes to the realization of a genuine low temperature process. The products are generated at the upper surface of the charge. By this surface they also escape, and are in no danger of having to penetrate a mass of material much hotter than themselves, as would be the case with gases generated in the middle of a charge heated by conduction from all round.

It is only during say one tenth of the period of distillation that the charge is in contact with a part of the shell directly heated by the furnace gases, and those furnace gases are at this point on their way to the chimney, and being almost spent can impart but little heat, while the charge having finished nine-tenths of its course through the higher or radiation heating part of the retort is almost completely decomposed and in the condition least suitable for absorbing conduction heat. It may therefore be said that this plays no part in the distillation effected by our retort.

I think the idea of a mechanical retort probably first suggested itself to some one who distilled small materials, and who found the strain on the shell of the retort, owing to the high temperature at the end of an operation, very destructive.

It was natural to suppose that some arrangement by which the charge could be stirred up and each particle brought in its turn within the influence of the heated shell would obviate this disadvantage. With some materials the difficulties to be overcome were not very serious, and there are many retorts with mechanism inside or outside of them, which appears very simple and little likely to be deranged by the heat, which have been patented; yet when it came to treating a substance difficult of manipulation when hot and of a delicate constitution chemically, the users of those retorts appear to have lost confidence in them.



RETORT WITH CONTINUOUS FEED AND DISCHARGE.

I have seen a horizontal cylindrical retort, capable of being rotated about its axis and consequently with all its mechanism outside, which after a dozen charges had a skin of coke three or four inches thick adhering to the inside of the shell, caused not by the decomposition of gaseous hydrocarbons like the carbon coke in a gas retort, but by the crumbling and melting of the substance with which it was charged, and which was deposited layer by layer as the retort revolved. As this deposit increased in thickness, the fire required to be urged, the distillate was less good, more coal was burned, the time to exhaust a charge greatly increased, and the chipping, which was done after a thorough cool down, was effected with considerable difficulty.

If this retort had been fitted with internal mechanism of the ordinary screw or chain type, the result would not have been greatly different, and I think the defect lies in allowing the substance to rest on a surface heated from underneath by the furnace, so that decomposition begins below, and the superincumbent charge increases the tendency to adhere not only by its weight but also by preventing the free evolution of the vapors.

Our retort, as you see by the drawing, consists of a vertical cylinder, with a diameter of eight feet at the bottom, which is increased by three inches at regular intervals till it is nine feet wide at the top and seven feet six inches high. Both top and bottom are closed by disks, each having a large hole at the center. Projecting upward from the top disk and downward from the bottom disk are sleeves which pass through the flues and brick work to the open air, and which are fitted at their extreme ends with stuffing glands, in which the center shaft, driven from below by gearing, revolves. The sleeves are much wider than is necessary for the passage of this shaft. It is through the upper one that the substance to be distilled is charged, the products being removed by the lower one. The center shaft, like the shell, is also stopped, but instead of increasing toward the upper end it diminishes in diameter. The steps or shoulders are arranged at different levels from those on the shell, so that the disks which rest on them are exactly midway between those which rest on the shell. The disks rest alternately on the shaft and on the shell; those on the shaft revolve with it, those on the shell are stationary. The disks on the shaft do not quite reach to the shell, but are smaller in diameter by about a foot; the disks on the shell have an opening in their centers, leaving an annular space round the shaft. From snugs cast on the underside of each plate are hung scrapers or deflectors which act like plows. Those hung from afixed disk, but working on a revolving disk, face toward the shell. Those hung from a revolving disk, but working on a fixed disk, face toward the shaft. All are arranged to deflect the material on the respective disks, outward from the shaft and inward from the shell. The material is put into the hopper on top either from hutches on an overhead railway or by means of a bucket elevator from the ground, and is thence forced by a screw to the branch on the upper sleeve; here it falls down alongside the shaft on to a moving plate near its center. As this plate moves slowly round, the material forms a ring upon it. This ring is interrupted by a deflector hung from the top cover, which pushes the material aside as fast as it comes round, and makes a larger ring while another small ring is being laid down. The large ring is again expanded into one still larger by another deflector, and so on until the outermost deflector pushes it over the edge of the disk on to the fixed disk below. As this deflector is itself fixed, the material falls on to the fixed disk at a fixed spot, and if left alone would pile up there, but certain deflectors hung from the end of the moving disk, and which (for simplicity, I will say) do not quite reach down to the fixed disk, are continually knocking the top off this heap and extending the material in a ribbon close to the shell. Here rings continue to be formed as before, but each succeeding one is lessened in diameter by a deflector hung from a moving disk, till all the material is pushed over the edge of the opening in the middle of the fixed disk. Here it arrives on the center of a moving plate as at the first, and the cycle of movements outward and inward is repeated with each pair of disks till the material arrives at the bottom of the retort. It then falls down a shoot in the bottom sleeve to the chain conveyor, and is carried out over the large bevel wheel to the double valve apparatus by which it is discharged into a wagon or otherwise removed.

By the arrangement of deflectors described, you will notice that the whole charge is not kept in continual motion, but that only a little of it is being moved at any one time. Less power is therefore necessary for driving, and the deflectors move out of the way and leave the newly turned up substance fully exposed.

The vapors generated or liberated travel in the same direction as the material, and pass to the condenser by the larger opening in the bottom sleeve. The heat, which may be supplied by a gas producer or furnace, according as one or other is suitable for burning the coal of the district, is first applied to the top of the retort, which is covered by an arch of special construction, and from thence passes by a zigzag course on both sides of the retort to the bottom, below which the flue gases escape to the chimney. You see that where the fire is hottest, the cold material is introduced, and when the material begins to decompose, the flue temperature is moderated, but always remains hotter than the material and imparts heat to it. This might not, at first sight, appear a good arrangement for insuring economy in coal consumption, for the flue gases, being above the decomposing temperature of the charge, convey a lot of heat to the chimney which might be used up in warming a fresh quantity of material to the distilling point. But it must be remembered that with the travel of the generated gases arranged as described, the temperature of volatilization of the heavier products is lowered undoubtedly, and it is possible that that of decomposition may, by the favoring conditions, be so as well, so that, though the hottest fire were applied below the retort, and the flue gases more thoroughly cooled by passing over the cold material above, it is doubtful if any economy would be gained, and it is certain that the equality of temperature at present existing, and which is valuable, would be lost. The number of disks may be varied to suit the nature of the substance to be distilled, but I think need not exceed 12.

The retort at present in use at our Paisley works has only eight plates, and on a consumption of less than 2¾ cwt. of coal per ton of wood puts through an average quantity of 12 tons per day of 24 hours. The wood is principally birch in the form of shavings from the bobbin makers. The retort represented by the sketch in your hands was sent abroad to distill shale. It has 10 plates and also puts through 12 tons per day,

but the coal used, which was of very poor quality, amounted to about 4 cwt. on the ton of shale. With Scotch coal I am sure this figure would be much lower.

The shell of the retort is made of cast iron one inch thick, and the disks, which are strengthened by ribs cast on their under side, have a thickness of ¾ of an inch; the total weight of an eight inch plate machine is about twenty tons, and the machine work necessary is trifling.

The brick work is simple, but I would like to draw your attention to the vault on the top, which is made so as to throw no strain on the side walls. Fireclay blocks with a check at each end are built into a "tee" iron curved to the circle of the outside of the vault and turned in at the ends, so that when the whole is lifted by a muzzle bolted to the web of the "tee" iron the bricks retain their position. Eight or ten of those arches of varying length when placed side by side cover the whole of the retort, and as the irons are not exposed to heat they bind the structure very firmly.

I regret I have been unable to show you a sketch embodying our most recent improvements, but the tracing handed round shows plainly the theoretical principles on which we work. The improvements I refer to are merely in the construction and enable us to have the castings made more cheaply. We now have the fixed and moving disks respectively made of one diameter, so that when shipped abroad one spare disk of each kind may be sent as a precaution against accident.

The discharging apparatus at the bottom of the retort is also simplified.

That the theory upon which the construction of the machine is based is a correct one is proved, not only by the small amount of coal used, but also by the excellent quality of the distillate produced. The wood used at our works, which, I believe, is stove-dried before being cut up, can contain no superfluous moisture to increase the quantity of distillate, and this quantity, which amounts to 140 gallons per ton, is, as far as I have been able to find out, much greater than that produced from air-dried billets commonly used in fixed retorts.

The specific gravity of the liquor after settling is about 1·09 or 18° Tw., showing that it contains much hydrocarbon matter. It shows by test between 13 and 14 per cent. of glacial acetic acid. The yield of charcoal is four cwt., and the amount lost by difference as incondensible gas is only two cwt.

The retort which treated shale produced a full yield of oil of an excellent quality, much better than that from fixed retorts. The exhaust steam from the engine which drove it was, without being superheated, passed into this retort.

The power required for driving is very little, and by calculation from the breadth and speed of the belts amounts to three horse power for the wood retort and five for the shale one.

We have treated two or three tons of seaweed with our machine, and the iodine left in the residue was greatly in excess of that usually found. The quantity unfortunately was too small to afford a test of the capacity of the retort for this purpose.—*Jour. Soc. Chem. Industry.*

TRANSMISSION OF POWER BY FLEXIBLE WIRE ROPE OR CABLE.

By Mr. J. E. EMMERSON, President Midgley Wire Belt Co.

IN the SUPPLEMENT of May 24, 1890, Mr. J. H. Gregg explained the advantages of the transmission of power by rope. Now comes up a new rope patented by Thomas Midgley, July 22, 1890. It is well known that in the use of manila ropes, specially for outdoor work,

SECTION OF MIDGLEY WIRE ROPE.

where they are subjected to storms, moisture and heat, the expansion and contraction is a very serious objection. In the use of the ordinary wire rope, the wires must bend in passing over pulleys for transmission, which soon causes them to fracture and break. In the Midgley method the wire rope or cable is formed into links similar to the Midgley flat wire belt, which has come into general use for ordinary belting or transmitting purposes where flat belts are used. Round belts are being largely substituted for all transmission. In the use of large engines for the transmission of power, the main driver is generally made with several grooves proportionate to the amount of power required. In forming these pulleys and grooves, it has been found practically impossible that all the pulleys can be made of exact size, so that there is a slight slippage in some of the several belts used for such purposes.

It is proposed in the Midgley process to enlarge the diameter of the flexible cables to suit any power required, so that but one cable may be used for any transmission. By use it has been found that a cable of the size illustrated, which is one inch in diameter, will transmit power equal to a flat belt of 8 inches in width, so that a flexible wire belt 3 inches in diameter would transmit fully the power of a 24 inch belt.

The Midgley belt is made hollow, and yields slightly to the groove in which it runs, when made a little smaller in diameter than the cable or flexible rope. By actual test it has been shown that one of the Midgley cables or flexible ropes, weighing 10 ounces to the foot in length, stands a tensile strain of 6,000 pounds, and is made of ordinary Bessemer wire.

This Midgley rope is now being made as small as ⅜ of an inch in diameter, and it may be used on any pulleys where ordinary rope is being used, and may be run on pulleys as small as 6 inches in diameter, and of any speed required. The Midgley rope is woven by very intricate and ingenious machinery devices, which shows that the inventor has given much thought to the subject.

We deem it unnecessary to repeat what was written by Mr. John H. Gregg in the SUPPLEMENT of May 24, 1890, which can be obtained at this office by any one interested in the subject matter, for ten cents a copy.

FRICTION OF JOURNAL BEARINGS.

MR. J. E. DENTON gives the following results of tests made with six M. C. B. brasses in a special testing machine, these results being given in a paper upon experiments with lubricants read before the Richmond meeting of the American Society of Mechanical Engineers:

The brasses were obtained from the Hopkins car brass foundry, without lead lining, and were dressed upon their rubbing surfaces with an emery wheel. They were of hexagonal form on their upper surface, which roughly fitted the ordinary rough cast iron saddle, inserted between the brass and the inner side of the top of the ordinary railway car box.

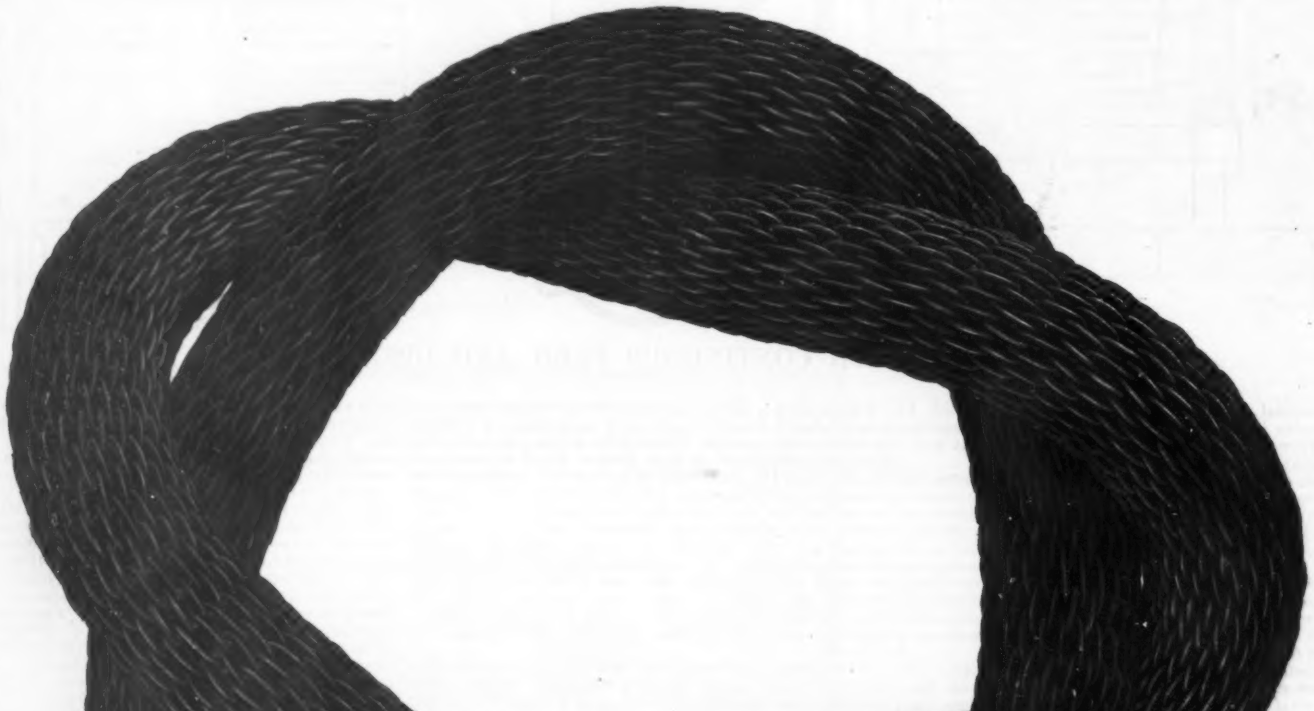
As explained in connection with the description of the machine, an eccentricity of bearing in the brass of 0·005 inch defeats any attempt to measure friction directly in any apparatus in which the pressure is all applied to the top brass.

Hence, with so rough and indeterminate a line of contact as exists between a car box and the hexagonal brass, it is not feasible to determine the friction except by observation of the temperatures of the bearings. While the latter is not a sufficiently accurate index of the coefficient of friction to determine variations of the latter when it falls below one-half of 1 per cent., yet a study of the data given for the concentric brasses will make it clear that the following basis of interpretation of the friction, from temperature, is practically acceptable.

1. At 170 revolutions per minute, and any load up to 10,000 lb., if the temperature increases at the rate of from one-third to one-half degree per minute, the coefficient of friction is less than one-half of 1 per cent., and there is no danger of overheating in any length of trial. A 30 minute run will then give the maximum temperature of the brass, which will be about 90 deg. Fahr. in a still atmosphere.

2. At 170 revolutions per minute, and any load up to 10,000 lb. load, if the temperature increases at the rate of one or more degrees per minute, so that at the end of 30 minutes' trial the temperature in a still atmosphere is upward of 120 deg., then the coefficient of friction is 3 or more per cent., and continued running would result in a "hot box."

The general programme followed is:



THE MIDGLEY WIRE ROPE.

1. To run ten minutes under 5,000 lb. load and then note the extent and character of the bearing.

2. To make two or more trials of 30 minutes under 5,000 and 10,000 lb. load, to determine the liability of the brass to overheat, or to run at minimum friction.

3. To use paraffine oil first and then follow with sperm under the most severe conditions to which the paraffine had been subjected, in order to discover any superior quality of sperm over the paraffine.

4. To artificially create heating with emery dust, so as to note to what extent grit, accidentally entering between bearings, could cause "hot boxes."

The method of lubrication was by a pad 3 in. by 6 in., pressed against the journal by springs, and taking its supply of oil with wicks. A reciprocating motion of 5-16 in. each way was maintained at the rate of about 35 double motions per minute. The following is a *resume* of the results in the tables, not including the cases where emery is used :

	Range of Press. per sq. in. lbs.	Times Tried.	Times Overheated.
Brass 1 at 5,000 lbs	2,250-4,300	2	1
" " " 10,000 "	1,300-4,500	3	0
" 2 " 5,000 "	1,600-4,000	2	1
" " " 10,000 "	2,900-3,100	2	0
" A " 5,000 "	1,250-2,000	2	0
" " " 10,000 "	1,100-2,250	3	0
" F " 5,000 "	1,400-2,250	2	0
" " " 10,000 "	2,100-3,200	5	0
" B " 5,000 "	1,800-3,500	2	1
" " " 10,000 "	1,800-3,300	3	2
" C " 5,000 "	1,200-1,300	3	2
" " " 10,000 "	2,000-2,400	3	0
Total		32	7

These figures show how purely a matter of chance is the overheating, as a brass which ran hot at 5,000 pounds load on one day would run cool on a later date at the same or higher pressure. The explanation of this apparently arbitrary difference of behavior is that the accidental variations of the smoothness of the surfaces, almost infinitesimal in their magnitude, cause variations of friction which are always tending to produce overheating, and it is solely a matter of chance when these tendencies preponderate over the lubricating influence of the oil. There is no appreciable advantage shown by the sperm oil when there is no tendency to overheat—that is, the paraffine can lubricate under the highest pressures which occur, as well as the sperm, when the surfaces are within the conditions affording the minimum coefficients of friction.

But when a few grains of emery are thrown between the bearings, intense heat is generated at the point of introduction. Under these circumstances the paraffine volatilizes and utterly destroys lubrication, while the sperm resists volatilization and makes the heating of the whole journal take place more slowly.

In other words, the sperm and other oils of high heat-resisting qualities, like vegetable oil and petroleum cylinder stocks, only differ from the more volatile lubricants like paraffine in their ability to reduce the chances of the continual accidental infinitesimal abrasion which produces overheating.

The lead-lined brass's record shows that it automatically adjusts itself to any irregularities in the journal, and finally secures minimum friction. The resistance of the lead to being scored by an excrescence, on the journal, is much less than that of the bare brass, so that while there is a temporary increase of friction, no very intense heat is created.

THE U. S. STEAMSHIP CHARLESTON.

THE new type of cruisers provided for the United States Navy shows an increase of size and power; and they are now built of steel, with deck of thick armor-plating. The Charleston, of which we give an illustration, is built of steel, 300 ft. long, by 46 ft. beam, with 3,730 tons displacement, and draws 18 ft. 6 in. water. She has twin screw propellers, worked by engines of 7,500 indicated horse power, giving an extreme speed of 19 knots an hour, and carries 800 tons of coal. The armament consists of two 10-inch breech-loading rifled guns; six 6-inch guns, of five tons; some machine guns; and five tubes, or launching carriages, for fish torpedoes.—*London Graphic.*

METAL HULLS OR WOODEN HULLS.

THE rage for steel or iron hulls, to displace the wooden structure, may not stop at tide water or even on our lakes, but may again encroach upon our inland rivers. Iron hulls for Western river boats have been already tried, and from the fact that few have been built, there must be some reason for the lack of faith in their usefulness or economy. Those iron hulls which have had their day on the Western rivers have all left their owners poorer, having either sunk or by a fire been warped so completely out of shape as to be utterly worthless.

They are difficult to repair from within in case of a perforation.

A metal hull, if "stove in," remains rigid in the position it is forced to, keeping the opening extended.

The wooden hull being more yielding is less liable to perforation, and even when broken through it has an elasticity which tends to press it back into its former position, and at least partially closes the opening, so that a very poor patch spiked to a wooden hull will stop a very big leak. To repair a metal hull requires a foundry.

The first cost of a metal hull is much greater than wood, and our Western river boatmen have not yet accepted the idea of the vaunted superior durability of metal to warrant the great difference in original cost.

On the contrary, the practical experienced steamboat man knows what he can do with a wooden hull, and has everything to learn about what can be done with one constructed of metal. The "know how" part of any business is a great factor in its success. Even an assured longevity of fifty years for a steel hull should be no incentive to build one upon the present models, for in ten years hence the models of to-day may be worthless as against the improved pattern of the next century. This state of affairs will apply to shallow water craft more especially than to the deep water vessels. The building of metal hulls for our Western rivers is as yet only experimental. The few that have been built lately are tugs or small sternwheelers, and have not been in commission long enough to figure upon. The impetus given to metal for marine architecture, for deep water, in the past few years, gives some idea of the strides it may take in the near future. Even the steel men have misgivings on the subject, and there are many conflicting ideas advocated.

At the recent convention, in Pittsburg, of the iron and steel men from all parts of the world, one of the most eminent of that notable assembly, Sir Nathaniel Barnaby, K.C.B., chief constructor of the British navy, read a paper "On the protection of iron and steel hulls against sinking from injury to their shells." He said:

"We are greatly worse off in these days of steel and iron than when hulls were built of oak, teak or pine, as to the perils arising from perforations by collision or other causes. The material of which the metal hull or shell is composed submits so easily to perforation that he was inclined to value the opinion of many eminent men who were strongly opposed to the abandonment of wooden bottoms, and we would probably find it to our advantage for many years to come to continue the use of wooden hulls, at least in the mercantile trade."

Those ideas prevail on his side of the ocean, and they are obliged to use metal there because of the difficulty of obtaining suitable timber at a reasonable price.

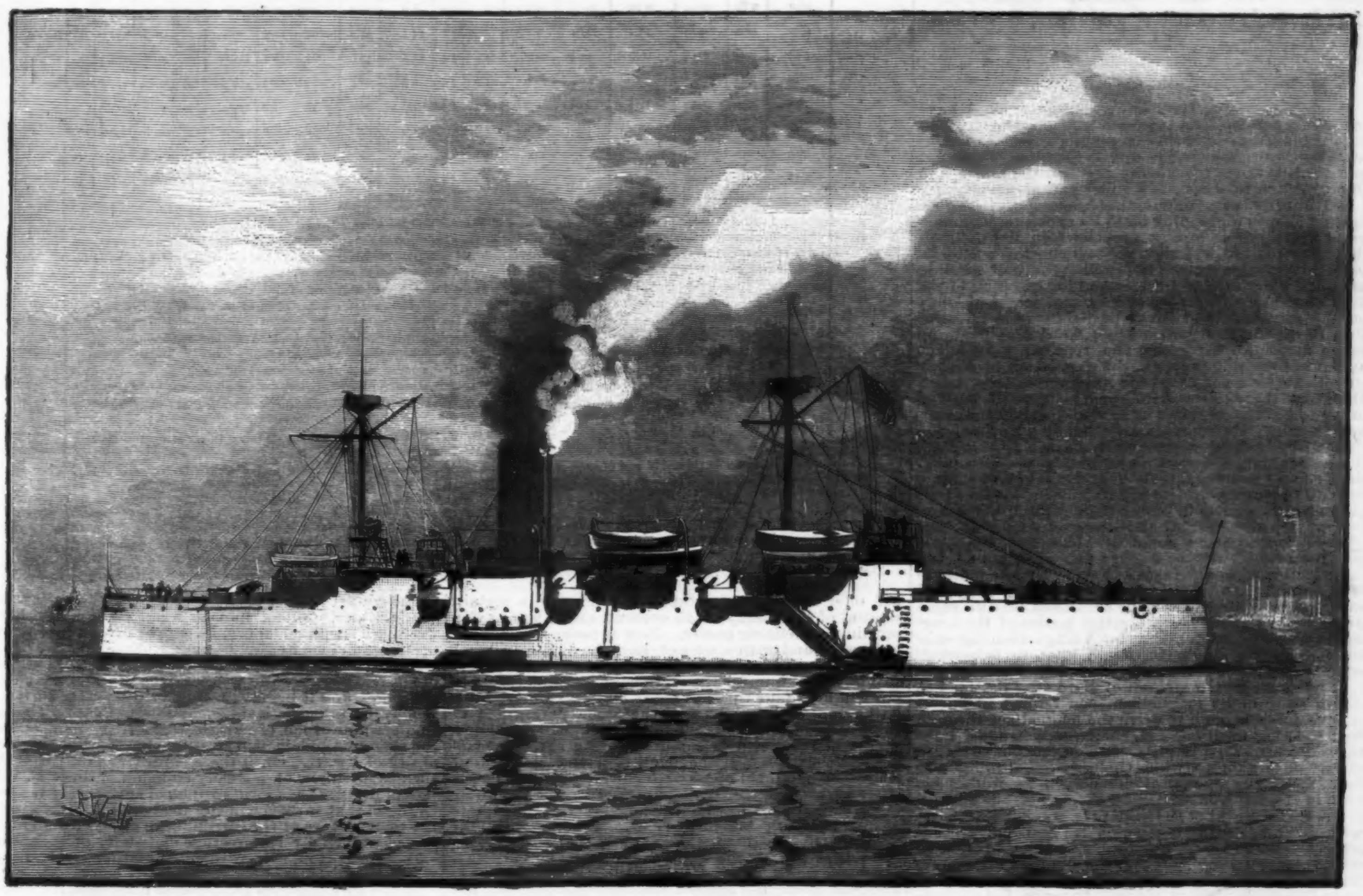
For this side of the water, our famous shipbuilder Wm. H. Webb, of New York, emphatically says:*

"Wood is undoubtedly the most suitable material for the construction of a ship."

The conclusion is without question. The specific gravity of oak at about 0·85 leaves some margin to float with. The specific gravity of iron at about 7·75 gives a weight to go down with. A water-logged iron hull not only goes down, but goes quickly. Many minds have been engaged in devising a stronger shell for the hull, by using metal, at nearly double the cost of wood, as the remedy against danger of sinking, losing sight of the fact that if the entire hull is flooded, it will sink, if made of any ordinary material. Others, bearing that particular danger in mind, have tried to devise some simple and inexpensive means for shallow waters to keep the entire hull from filling, and a recently invented system (secured through the SCIENTIFIC AMERICAN agency) of water tight compartments and doors, which costs a few cents per foot and is of little weight, may probably be the means of saving more hulls in the near future than can now be estimated.

With such safeguards, only one, two or three compartments can possibly admit water, while the uninjured compartments will float the boat. One very great disadvantage to the wooden hulls of our Western rivers is the immense surplus weight of timber they carry, presumably to fill the requirements of the underwriters. Timber and bolts are put in till some hulls are veritable piles of timber, bolted and spiked together, and as a rule draw twenty per cent. more water than they should.

With the present well known systems of bracing wood with iron rods and plates, much of this weight could be discarded, and the gain in lighter draught would pay for any probable difference in cost. The entire absence of any recent established scale of essential strength leaves the owner and builder at the mercy of the one man who inspects the boat, and that



THE U. S. S. CHARLESTON.

* SCIENTIFIC AMERICAN, December 13, 1890.

overhanging fear that she may not pass inspection entails a useless expense and superfluous weight, nor is there any certainty that because she passes inspection at one port, she would also pass at some other. That element of uncertainty should unquestionably be removed, and it would result in benefit to all concerned.

A standard of size, strength, and requirements for safety instead of the dimensions of thirty years ago should be established, and known beforehand to the builder, approximately, for the sized boat it was proposed to build. Such a regulation is as easy to comply with as are the present governmental regulations as to hatches, stairways, life boats, fire buckets, life preservers, etc.

It is generally believed that the point of safety can be secured with far less material than is now used; besides the lighter draught, better speed can be attained, and fewer accidents.

By the use of compartments, less strength would be required than if the entire hull was liable to fill.

There are many sound wooden hulls afloat with many years of good service before them if provided with bulkhead safeguards against sinking. Would it not be well to protect those we have by a small outlay rather than build new hulls of metal, at least at present prices?

The interests of humanity demand some such protection for life and property, to prevent the startling announcements of disaster, which the daily press always delights to put in big black type, with harrowing details.

Any means which will prevent such losses will be gladly welcomed by the public.

[Continued from SUPPLEMENT, No. 785, page 12540.]

THE ELECTROMAGNET.*

By Professor SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

III.

SPECIAL DESIGNS.

IN continuation of my lecture of last week, I have to make a few remarks before entering upon the consideration of special forms of magnets, which was to form the entire topic of to-night's lecture. I had not quite finished the experimental results which related to the performance of magnets under various conditions. I had already pointed out that where you require a magnet simply for holding on to its armature, common sense (in the form of our simplest formula) dictated that the circuit of iron should be as short as was compatible with getting the required amount of winding upon it. That at once brings us to the question of the difference in performance of long magnets and short ones. Last week we treated that topic so far as this, that if you require your magnet to attract over any range across an air space, you required a sufficient amount of exciting power in the circulation of electric current to force the magnetic lines across that resistance, and therefore you required length of core in order to get the required coil wound upon the magnetic circuit. But there is one other way in which the difference of behavior between long and short magnets (I am speaking of horseshoe shapes) comes into play. So far back as 1840, Ritchie found that it was more difficult to magnetize steel magnets (using for that purpose electromagnets to stroke them with) if those electromagnets were short than if they were long. He was of course comparing magnets which had the same tractive power, that is to say, presumably had the same section of iron magnetized up to the same degree of magnetization. This difference between long and short cores is obviously to be explained on the same principle as the greater projecting power of the long-legged magnets. In order to force magnetism not only through an iron arch but through whatever is beyond, which has a lesser permeability for magnetism, whether it be an air gap or an arch of hard steel destined to retain some of its magnetism, you require magnetomotive force enough to drive the magnetism through that resisting medium, and, therefore, you must have turns of wire. That implies that you must have length of leg on which to wind those turns. Ritchie also found that the amount of magnetism remaining behind in the soft iron arch, after turning off the current at the first removal of the armature, was a little greater with long than with short magnets; and, indeed, it is what we should expect now, knowing the properties of iron, that long pieces, however soft, retain a little more, have a little more memory, as it were, of having been magnetized, than short pieces. Later on I shall have specially to draw your attention to the behavior of short pieces of iron which have no magnetic memory.

WINDING OF THE COPPER.

I now take up the question of winding the copper wire upon the electromagnet. How are we to determine beforehand the amount of wire required, and the proper gauge of wire to employ?

The first stage of such a determination is already accomplished; we are already in possession of the formulæ for reckoning out the number of ampere turns of excitation required in any given case. It remains to show how from this to calculate the amount of bobbin space, and the quantity of wire to fill it. Bear in mind that a current of ten amperes (*i. e.*, as strong as that used for a big arc light) flowing once around the iron produces exactly the same effect magnetically as a current of one ampere flowing around ten times, or as a current of only one hundredth part of an ampere flowing around a thousand times. In telegraphic work the currents ordinarily used in the lines are quite small, usually from five to twenty thousandths of an ampere; hence in such cases the wire that is wound on need only be a thin one, but it must have a great many turns. Because it is thin and has a great many turns, and is consequently a long wire, it will offer a considerable resistance. That is no advantage, but does not necessarily imply any greater waste of energy than if a thicker coil of fewer turns were used with a correspondingly larger current. Consider a very simple case. Suppose a bobbin is already filled with a certain number of turns of wire, say 100, of a size large enough to carry one ampere, without overheating. It

* Lectures delivered before the Society of Arts, London, 1890. From the Journal of the Society.

TABLE X.—WIRE GAUGE AND AMPERAGE TABLE.

Dimensions.					Permissible Amperage, Probable Heating, and Permissible Depth.											
S. W. G.	Diam. (inch.)	Section. (sq. inch bare.)	Turns to 1 linear inch. (covered.)	Turns per sq. inch. (covrd.)	At 1,000 Amps. to sq. inch.			At 2,000 Amps. to sq. inch.			At 3,000 Amps. to sq. inch.			At 4,000 Amps. to sq. inch.		
					A	F	D	A	F	D	A	F	D	A	F	D
22	·028	·00062	23·81	624·	·616	2·28	4·5	1·23	9·12	1·13	1·85	20·52	·50	2·46	36·5	·28
20	·036	·0010	20·00	440·	1·018	3·18	3·9	2·036	12·72	·97	3·05	28·62	·43	4·07	50·9	·24
19	·040	·0012	18·52	377	1·26	3·56	3·6	2·52	14·24	·92	3·78	32·04	·41	5·04	57·0	·23
18	·048	·0018	16·13	285	1·81	4·64	3·3	3·62	18·56	·83	5·43	41·76	·37	7·24	74·2	·21
17	·056	·0024	14·28	224	2·4	5·47	3·2	4·8	21·9	·79	7·2	49·2	·35	9·6	87·5	·19
16	·064	·0032	12·83	181	3·2	6·57	3·0	6·4	26·3	·74	9·6	59·1	·33	12·8	105·1	·18
15	·072	·0040	11·63	149	4·0	7·40	2·9	8·0	29·6	·72	12·0	66·6	·32	16·0	118·4	·17
14	·080	·0050	10·64	124	5·0	8·46	2·8	10·0	33·8	·70	15·0	76·3	·31	20·0	135·4	·17
13	·092	·0060	9·44	98·2	6·6	9·97	2·7	13·2	39·9	·67	19·8	89·7	·30	26·4	159·5	·16
12	·104	·0085	8·48	79·1	8·5	11·53	2·6	17·0	46·1	·65	25·5	103·8	·29	34·0	184·4	·16
11	·116	·0105	7·60	65·0	10·5	12·8	2·5	21·0	51·2	·63	31·5	115·2	·28	42·0	204·8	·16
10	·128	·0128	7·04	54·5	12·8	14·3	2·4	25·6	57·2	·61	38·4	128·7	·27	51·2	228·8	·15
9	·144	·0163	6·33	44·1	16·3	16·4	2·4	32·6	65·6	·60	48·9	147·6	·27	65·2	262·4	·15
8	·160	·0201	5·74	36·3	20·1	18·4	2·3	40·2	73·6	·59	60·3	165·6	·26	80·4	294·4	·15
7	·176	·0243	5·26	30·4	24·3	20·4	2·3	48·6	81·6	·58	72·9	183·6	·26	97·2	326·4	·15
Stranded,																
7/22	0·84	·0043	9·69	101·8	4·3	6·73	4·0	8·6	26·9	·99	12·9	24·6	·44	17·2	107·7	·25
7/20	·108	·0072	7·81	67·1	7·13	8·94	3·7	14·3	35·7	·92	21·4	80·5	·48	28·5	143·0	·23
7/18	·144	·0128	6·09	40·8	12·7	12·4	3·4	25·4	49·6	·83	38·1	111·6	·39	50·8	198·4	·21
7/16	·192	·0229	5·10	28·6	22·9	17·2	3·2	45·8	68·7	·79	68·7	154·5	·35	91·6	274·7	·20
7/15	·216	·0289	4·27	20·1	28·9	19·5	3·1	57·8	78·0	·78	86·7	175·4	·34	115·6	311·8	·20
7/14	·240	·0356	3·87	16·5	35·6	21·8	3·1	71·2	87·1	·76	106·8	195·9	·34	142·4	348·3	·19
7/13	·276	·0462	3·38	12·6	46·2	24·7	3·0	92·4	98·8	·74	138·6	222·3	·33	184·8	395·2	·19
7/12	·312	·0595	3·01	9·97	59·5	28·5	2·9	179·0	114·0	·72	178·5	256·5	·32	238·0	456·	·18

Figures in columns marked A signify number of ampères that the wire carries.

Figures in columns marked F signify number of degrees (Fahrenheit) that the coil will warm up if there is only one layer of wire, and on the assumption that the heat is radiated only from the outer surface of the coil: they are calculated by the following modification of Forbes's rule:—

Rise in temperature (Fahrenheit degrees) = 225 × No. of watts lost per sq. inch.
= 150 × sectional area × number of turns to 1 inch (at 1,000 Amps. per sq. inch).

Figures in columns marked D are the depths in inches to which wire may be wound if 1 watt be lost by each square inch of radiating surface, the outside radiating surface of the bobbin being only considered.

Rule for calculating a 7-strand cable:—Diam. of cable = 1·134 × diam. of equivalent round wire.

Figures under heading "Turns to 1 linear inch" are calculated for cotton-covered wires of average thicknesses of coverings used for the different gauges, viz., 14 mils additional diameter on round wires (from No. 22), and 20 mils on stranded or square wire.

Figures under heading "Turns per square inch" are calculated from preceding, allowing 10 per cent. for bedding of layers.

Resistance (ohms) of coil of copper wire, occupying v cubic inches of coil-space and of which the gauge is d mils uncovered, and D mils covered, may be approximately calculated by the rule:—

$$\text{ohms} = 960700 \frac{v}{D^2 d^2}$$

The data respecting sizes of wires of various gauges are kindly furnished by the London Electric Wire Company.

will offer a certain resistance, it will waste a certain amount of the energy of the current, and it will have a certain magnetizing power. Now suppose this bobbin to be rewound with a wire of half the diameter, what will the result be? If the wire is half the diameter, it will have one quarter the sectional area, and the bobbin will hold four times as many turns (assuming insulating materials to occupy the same percentage of the available volume). The current which such a wire will carry will be one-fourth as great. The coil will offer sixteen times as much resistance, being four times as long and of one-fourth the cross section as the other wire. But the waste of energy will be the same, being proportional to the resistance and to the square of the current; for $16 \times \frac{1}{16} = 1$. Consequently the heating effect will be the same. Also the magnetizing power will be the same, for though the current is only one quarter of an ampere, it flows around four hundred turns; the ampere turns are one hundred, the same as before.

The same argument would hold good with any other numerical instance that might be given. It therefore does not matter in the least to the magnetic behavior of the electromagnet whether it is wound with thick wire or thin wire, provided the thickness of the wire corresponds to the current it has to carry, so that the same number of watts of power are spent in heating it. For a coil wound on a bobbin of given volume the magnetizing power is the same for the same heat waste. But the heat waste increases in a greater ratio than the magnetizing power, if the current in a given coil is increased, for the heat is proportional to the square of the current, and the magnetizing power is simply proportional to the current. Hence it is the heating effect which in reality determines the winding of the wire. We must—assuming that the current will have a certain strength—allow enough volume to admit of our getting the requisite number of ampere turns without overheating. A good way is to assume a current of one ampere while one calculates out the coil. Having done this, the same volume holds good for any other gauge of wire appropriate to any other current. The terms "long coil" magnet and "short coil" magnet are appropriate for those electromagnets which have, respectively, many turns of thin wire and few turns of thick wire. These terms are preferable to "high resistance" and "low resistance," sometimes used to designate the two classes of winding, because, as I have just shown, the resistance of a coil has in itself nothing to do with its magnetizing power. Given the volume occupied by the copper, then for any current density (say for example a current density of 2,000 amperes per square inch of cross section of the copper) the magnetizing power of the coil will be the same for all different gauges of wire. The specific conductivity of the copper itself is of importance, for the better the conductivity, the less the heat waste per cubic inch of winding. High conductivity copper is therefore to be preferred in every case.

Now the heat which is thus generated by the current of electricity raises the temperature of the coil (and of the core), and it begins to emit heat from its surface. It may be taken as a sufficient approximation that a single square inch of surface, warmed 1° Fah. above the surrounding air, will steadily emit heat at the rate of $\frac{1}{225}$ of a watt. Or, if there is provided only enough surface to allow of a steady emission of heat at the rate of one watt* per square inch of surface, the temperature of that surface will rise to about 225° Fah. above the temperature of the surrounding air. This number is determined by the average emissivity of such substances as cotton, silk, varnish, and other materials of which the surfaces of coils are usually composed.

In the specifications for dynamo machines, it is usual to lay down a condition that the coils shall not heat more than a certain number of degrees warmer than the air. With electromagnets it is a safe rule to say that no electromagnet ought ever to heat up to a temperature more than 100° Fahr. above the surrounding air. In many cases it is quite safe to exceed this limit.

The resistance of the insulated copper wire on a bobbin may be approximately calculated by the following rule. If d is the diameter of the naked wire, in mils, and D is the diameter, in mils, of the wire when covered, then the resistance per cubic inch of the coil will be:

$$\text{Ohms per cub. inch} = \frac{960{,}700}{D^2 \times d^2}$$

We are therefore able to construct a wire gauge and amperage table which will enable us to calculate readily the degree to which a given coil will warm when traversed by a given current, or conversely what volume of coil will be needed to provide the requisite circulation of current without warming beyond any prescribed excess.

Accordingly, I here give a *Wire Gauge and Amperage Table*, which we have been using for some time at Finsbury Technical College. It was calculated out

* The *watt* is the unit of rate of expenditure of energy, and is equal to ten million ergs per second, or to 1-746th of a horse power. A current of one ampere, flowing through a resistance of one ohm, spends energy in heating at the rate of one watt. One watt is equivalent to 4·2 calories per second of heat. That is to say, the heat developed in one second, by expenditure of energy at the rate of one watt, would suffice to warm one gramme of water through 4·2 (Centigrade) degrees. As 252 calories are equal to one British (lb. Fahrenheit) unit of heat, it follows that heat emitted at the rate of one watt would suffice to warm 17⅛ pounds of water one degree Fahrenheit in one minute; or one British unit of heat equals 1,058 watt seconds.

under my instructions by one of the demonstrators of the college, Mr. Eustace Thomas, to whom I am indebted for the great care bestowed upon the calculations.

For many purposes, such as for use in telegraphs and electric bells, smaller wires than any of those mentioned in the table are required. The table is, in fact, intended for use in calculating magnets in larger engineering work.

A rough and ready rule sometimes given for the size of wire is to allow $\frac{1}{1000}$ square inch per ampere. This is an absurd rule, as the figures in the table show. Under the heading 1,000 amperes to square inch, it appears if a No. 18 S.W.G. wire is used, it will at that rate carry 1·81 amperes; that if there is only one layer of wire, it will only warm up 4·64° Fahr., consequently one might wind layer after layer to a depth of 3·3 inches without getting up to the limit of allowing one square inch per watt, for the emission of heat. In very few cases does one want to wind a coil so thick as 3·3 inches. For very few electromagnets is it needful that the layer of coil should exceed ½ an inch in thickness; and if the layer is going to be only ½ an inch thick, or about $\frac{1}{7}$ of the 3·3, one may use a current density $\sqrt{7}$ times as great as 1,000 amperes per square inch, without exceeding the limit of safe working. Indeed, with coils only ½ inch thick, one may safely employ a current density of 3,000 amperes per square inch, owing to the assistance which the core gives for the dissipation and emission of heat.

Suppose, then, we have designed a horseshoe magnet, with a core 1 inch in diameter, and after considering the work it has to do, it is found that the magnetizing power of 2,400 turns is required; suppose also that it is laid down as a condition that the coil must not warm up more than 50° Fahr. above the surrounding air—what volume of coil will be required? Assume first that the current will be 1 ampere; then there will have to be 2,400 turns of a wire which will carry 1 ampere. If we took a No. 20 S. W. G. wire and wound it to a depth of ½ an inch, that would give 250 turns per inch length of coil; so that a coil 11 inches long and a little over ½ inch deep (or ten layers deep) would give 2,400 turns. Now Table X. shows that if this wire were to carry 1·918 ampere, it would heat up 225° Fahr. if wound to a depth of 3·9 inches. If wound to ½ inch, it would therefore heat up about 30° Fahr., and with only one ampere would of course heat less. This is too good; try the next thinner wire. No. 22, S. W. G. wire, at 2,000 amperes to square inch, will carry 1·23 amperes; and heats 225° if wound up 1·13 inches. If it is only to heat 50° it must not be wound more than ¼ inch deep; but if it only carries current of 1 ampere it may be wound a little deeper—say to 14 layers. There will then be wanted a coil about 7 inches long to hold the 2,400 turns. The wire will occupy about 3·85 square inches of total cross section; and the volume of the space occupied by the winding will be 26·95 cubic inches. Two bobbins, each 3½ inches long and 0·65 deep, to allow for 14 layers, will be suitable to receive the coils.

By the light of the knowledge one possesses as to the relation between emissivity of surface, rate of heating by current, and limiting temperatures, it is seen how little justification there is for such empirical rules as that which is often given, namely, to make the depth of coil equal to the diameter of the iron core. Consider this in relation to the following fact, that in all those cases where leakage in negligible, the number of ampere turns that will magnetize up a thin core to any prescribed degree of magnetization will magnetize up a core of any section whatever, and of the same length, to the same degree of magnetization. A rule that would increase the depth of copper proportionately to the diameter of the iron core is absurd.

Where less accurate approximations are all that is needed, more simple rules can be given. Here are two cases:

Case 1. *Leakage assumed to be negligible.*—Assume $\mathbf{B} = 16{,}000$, then $\mathbf{H} = 50$ (see Table III). Hence the ampere turns per centimeter of iron will have to be 40, or per inch of iron 102, for $\mathbf{H}$ is equal to 1·2566 times the ampere turns per centimeter. Now if the winding is not going to exceed ½ inch in depth, we may allow 4,000 amperes per square inch without serious overheating. And the 4,000 ampere turns will require 2-inch length of coil, or each inch of coil carries 2,000 ampere turns without overheating. Hence each inch of coil ½ inch deep will suffice to magnetize up 20 inches length of iron to the prescribed degree.

Case 2. *Leakage assumed to be 50 per cent.*—Assume $\mathbf{B}$ in air gap $= \mathbf{H} = 8{,}000$, then to force this across requires ampere turns 6,400 per centimeter of air, or 16,250 per inch of air. Now if winding is not going to exceed ½ inch depth, each inch length of coil will carry 2,000 ampere turns. Hence, 8 inches length of coil ½ inch deep will be required for 1 inch length of air, magnetized up to the prescribed degree.

WINDINGS FOR CONSTANT PRESSURE AND FOR CONSTANT CURRENT.

In winding coils for magnets that are to be used on any electric light system, it should be carefully borne in mind that there are separate rules to be considered according to the nature of the supply. If the electric supply is at *constant pressure*, as usual for glow lamps, the winding of coils of electromagnets follows the same rule as the coils of voltmeters. If the supply is with *constant current*, as usual for arc lighting in series, then the coils must be wound with due regard to the current which the wire will carry, when lying in layers of suitable thickness, the number of turns being in this case the same whether thin or thick wire is used.

If we assume that a safe limit of temperature is 90° Fahr. higher than the surrounding air, then the largest current which may be used with a given electromagnet is expressed by the formula:

$$\text{Highest permissible amperes} = 0{\cdot}63\sqrt{\frac{s}{r}}$$

where s is the number of square inches of surface of the coils, and r their resistance in ohms.

Similarly for coils to be used as shunts we have:

$$\text{Highest permissible volts} = 0{\cdot}63\sqrt{s\,r}$$

The magnetizing power of a coil, supplied at a given number of volts of pressure, is independent of its length, and depends only on its gauge, but the longer the wire, the *less* will be the heat waste. On the contrary, when the condition of supply is with a constant number of amperes of current, the magnetizing power of a coil is independent of the gauge of the wire, and depends only on its length, but the larger the gauge, the less will be the heat waste.

MISCELLANEOUS RULES ABOUT WINDING.

To reach the same limiting temperature with bobbins of equal size wound with wires of different gauge, the cross section of the wire must vary with the current it is to carry, or, in other words, the current density (amperes per square inch) must be the same in each.

Table X. shows the amperages of the various sizes of wires, at four different values of current density.

To raise to the same temperature two similarly shaped coils, differing in size only, and having the gauges of the wires in the same ratio (so that there are the same number of turns on the large coil as on the small one), the currents must be proportional to the square roots of the cubes of the linear dimensions.

Sir William Thomson has given a useful rule for calculating windings of electromagnets of the same type but of different sizes. Similar iron cores, similarly wound with lengths of wire proportional to the squares of their linear dimensions, will, when excited with equal currents, produce equal intensities of magnetic field at points similarly situated with respect to them.

Similar electromagnets of different sizes must have ampere turns proportional to their linear dimensions if they are to be magnetized up to an equal degree of saturation.

It is curious what erroneous notions crop up from time to time about winding electromagnets. In 1869, a certain Mr. Lyttle took out a patent for winding the coils in the following way. Wind the first layer as usual, then bring the wire back to the end where the winding began and wind a second layer, and so on. In this way all the windings will be right handed, or else all left handed, not alternately right and left as in the ordinary winding. Lyttle declared that this method of winding a coil gave more powerful effects. So did M. Brisson, who reinvented the same mode of winding in 1873, and solemnly described it. Its alleged superiority was at once disproved by Mr. W. H. Preece, who found the only difference to be that there was more difficulty in carrying out this mode of winding.

Another popular error is that electromagnets in which the wires are badly insulated are more powerful than those in which they are well insulated. This arose from the ignorant use of electromagnets having long thin coils (of high resistance) with batteries consisting of a few cells (of low electromotive force). In such cases, if some of the coils are short-circuited, more current flows, and the magnetizing power may be greater.

But the scientific cure is either to rewind the magnet with an appropriate coil of thick wire, or else to apply another battery having an electromotive force that is greater.

SPECIFICATIONS OF ELECTROMAGNETS.

One frequently comes across specifications for construction which prescribe that an electromagnet shall be wound so that its coil shall have a certain resistance. This is an absurdity. Resistance does not help to magnetize the core. A better way of prescribing the winding is to name the ampere turns and the temperature limit of heating. Another way is to prescribe the number of watts of energy which the magnet is to take.

Indeed, it would be well if electricians could agree upon some sort of figure of merit by which to compare electromagnets, which should take into account the magnetic output—*i. e.*, the product of magnetic flux into magnetomotive force—the consumption of energy in watts, the temperature rise, and the like.

AMATEUR RULE ABOUT RESISTANCE OF ELECTROMAGNET AND BATTERY.

In dealing with this question of winding copper on a magnet core, I cannot desist from referring to that rule which is so often given, which I often wish might disappear from our text books—the rule which tells you in effect that you are to waste 50 per cent. of the energy you employ. I refer to the rule which states that you will get the maximum effect out of an electromagnet if you so wind it that the resistance is equal to the resistance of the battery you employ, or that if you have a magnet of a given resistance, you ought to employ a battery of the same resistance. What is the meaning of this rule? It is a rule which is absolutely meaningless unless in the first case the volume of the coil is prescribed once for all, and you cannot alter it, or unless once for all the number of battery elements that you can have is prescribed. If you have to deal with a fixed number of battery elements, and you have to get out of them the biggest effect in your external circuit, and cannot beg, buy, or borrow any more cells, it is perfectly true that, for steady currents, you ought to group them so that their internal resistance is equal to the external resistance that they have to work through, and then, as a matter of fact, half the energy of the battery will be wasted, but the output will be a maximum. Now that is a very nice rule indeed for amateurs, because an amateur generally starts with the notion that he does not want to economize in his rate of working. It does not matter whether the battery is working away furiously, heating itself and wasting a lot of power. All he wants is to have the biggest possible effect for a little time out of the fewest cells.

It is purely an amateur's rule, therefore, about equating the resistance inside to the resistance outside. But it is absolutely fallacious to set up any such rule for serious working. And not only fallacious, but absolutely untrue if you are going to deal with currents that are going to be turned off and on quickly. For any apparatus like an electric bell, or rapid telegraph, or induction coil, or any of those things where the current is going to vary up and down rapidly, it is a false rule, as we shall see presently.

What is the real point of view from which one ought to start? I am often asked questions by, shall I say, amateurs as well as by those who are not amateurs, about prescribing the battery for a given electromagnet, or prescribing an electromagnet for a given battery. Again, I am often told of cases of failure in which a very little common sense rightly directed might have made a success. What one ought to think about in every case is not the battery, not the electromagnet, but *the line*. If you have a line, then you must have a battery and electromagnet to correspond. If the line is short and thick, a few feet of good copper wire, you should have a short thick battery (a few big cells, or one big cell), and a short thick coil on your electromagnet. If you have a long thin line, miles of it, say, you want a long thin battery (small cells, and a long row of them) and a long thin coil. That is then our rule; for a short thick line, a short thick battery, and a short thick coil; for a long thin line, a long thin battery; and electromagnet coils to match. You smile; but it is a really good rule that I am giving you; vastly better than the wornout amateur rule.

But, after all, my rule does not settle the whole question, because there is something more than the whole resistance of the circuit to be taken into account. Whenever you come to rapidly acting apparatus, you have to think of the fact that the current, while varying, is governed not so much by the resistance as by the inertia of the circuit—its electromagnetic inertia. As this is a matter which will claim our special attention hereafter, I will leave battery rules for the present, and proceed with the question of design.

FORMS OF ELECTROMAGNETS.

This at once leads us to consider the classification of forms of magnets. I do not pretend to have found a complete classification. There is a very singular book written by Mons. Nicklès, in which he classifies under 37 different heads all conceivable kinds of magnets, bidromic, tridromic, monocnemic, multidromic, and I do not know how many more; but the classification is both unmeaning and unmanageable. For my present purpose I will simply pick out those which come under three or four heads, and deal separately with others that do not quite fit under any of the four categories.

Bar Electromagnets.—In the first place there are those which have a straight core, of which there are several specimens on the table here.

Horse-shoe Electromagnets.—Then there are the horse-shoes, of which some are of one piece bent, and others are of the more frequent shape, made of three pieces.

Iron-clad Electromagnets.—Then from the horse-shoes I go to those magnets in which the return circuit of the iron comes back outside the coil either from one end or the other, or from both ends, sometimes in the form of an external tube or jacket, sometimes merely with a parallel return yoke, or two parallel return yokes. All such magnets I propose to call—following the fashion that has been adopted for dynamos—iron-clad electromagnets. One of them, the jacketed electro-magnet, is shown in Fig. 12, and there are others not so well known. There is one used by Mr. Cromwell Varley, in which a straight magnet is placed between a couple of iron caps, which fit over the ends, and virtually bring the poles down close together; the circular rim of one cap being the north pole, and that of the other cap being the south pole, the two rims being close together. That plan, of course, produces a great tendency to leak across from one rim to the other all round. The advantages, as well as the disadvantages, of the jacketed magnet I alluded to in my last lecture, when I pointed out to you that for all action at a distance it is far better not to have an iron-clad return path, whereas for action in contact the iron-clad magnet was distinctly a very good form. In one form of iron-clad magnet the end of the straight central core is fixed to the middle of a bar of iron, the ends of which are bent up and brought flush with the top of the bobbin, making thus a tripolar magnet, with one pole between the other two. The armature in this form is a bar which lies right across the three poles. There is an example of this excellent kind of electromagnet applied in one of the forms of electric bell indicator made by Messrs Gent, of Leicester.

Then besides these three main classes—the straight bar, the horse-shoe, and the iron-clad—there is another form which is so useful and so commonly employed in certain work that it deserves to have a name of its own. It is that called by Count Du Moncel the *aimant boiteux*, or club-footed magnet (Fig. 50). It is a

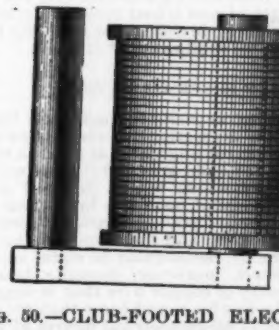


FIG. 50.—CLUB-FOOTED ELECTROMAGNET.

horse-shoe in fact, with a coil upon one pole and no coil upon the other. The advantage of that construction is simply, I suppose, that you will save labor—you will only have to wind the wire on one pole instead of two. Whether that is an improvement in any other sense is a question for experiment to determine; but on which theory perhaps might now be able to say something. Count Du Moncel, who made many experiments on this form of magnet, ascertained that there was for an equal weight of copper a slight falling off in power with the club-footed magnet. Indeed, one might almost predict, for a given weight of copper, if you wound all in one coil only, you will not make as many turns as if you wound it in two; the outer turns on the coil being so much larger than the average turn when wound in two coils. Consequently the number of ampere turns with a given weight of copper would be rather smaller, and you would require more current to bring the magnetizing power up to the same value as with the two coils. At the same time the one coil may be produced a little more cheaply than the two;

and indeed such electromagnets are really quite common, being largely used, for the sake of cheapness and compactness, in indicators of electric bells.

Du Moncel tried various experiments about this form to find whether it acted better when the armature was pivoted over one pole or over the other, and found it worked best when the armature was actually hinged on to that pole which comes up through the coil. He made two experiments, trying coils on one or other limb, the armature being in each case set at an equal distance. In one experiment he found the pull was 35 grammes, with an armature hinged on to the idle pole, and 40 grammes when it was hinged on to the pole which carried the coil.

Another form of electromagnet, having but one coil, is used in the electric bells of church bell pattern, of which Mr. H. Jensen is the designer. In Jensen's electromagnet a straight cylindrical core receives the bobbin for the coil, and after this has been pushed into its place, two ovate pole pieces are screwed upon its end, serving thus to bring the magnetic circuit across the ends of the bobbin, and forming a magnetic gap along the side of the bobbin. The armature is a rectangular strip of soft iron, about the same length as the core, and is attracted at one end by one pole piece, and at the other end by the other.

EFFECT OF SIZE OF COILS.

Seeing that the magnetizing power which a coil exerts on the magnetic circuit which it surrounds is simply proportional to the ampere-turns, it follows that those turns which lie on the outside layers of the coil, though they are further away from the iron core, possess precisely equal magnetizing power. This is strictly true for all closed magnetic circuits; but in those open magnetic circuits where leakage occurs it is only true for those coils which encircle the leakage lines also. For example, in a short bar electromagnet, of the wide turns on the outer layer, those which encircle the middle part of the bar do inclose all the magnetic lines, and are just as operative as the smaller turns that underlie them; while those wide turns which encircle the end portions of the bar are not so efficient, as some of the magnetic lines leak back past these coils.

EFFECT OF POSITION OF COILS.

Among the other researches which Du Moncel made with respect to electromagnets was one on the best position for placing the coil upon the iron core. This is a matter that other experimenters have examined. In Dub's book, "Electromagnetismus," to which I have several times referred, you will also find many experiments on the best position of a coil; but it is perhaps sufficient to narrate a single example. Du Moncel had four pairs of bobbins made of exactly the same length, and with 50 meters of wire on each; one pair was 16 centimeters long, another pair 8 centimeters, or half the length, with not quite so many turns, because, of course, the diameter of the outer turns was larger; one 4 centimeters in length, and another 2 centimeters. These were tried both with bar magnets and horse-shoes. It will suffice perhaps to give the result of the horse-shoe. The horse-shoe was made long enough—16 centimeters only, a little over 6 inches long—to carry the longest coil. Now when the compact coils 2 centimeters long were used, the pull on the armature at a distance away of 2 millimeters (it was always the same, of course, in the experiments) was 40 grammes. Using the same weight of wire, but distributed on the coils twice as long, the pull was 55 grammes. Using the coils 8 centimeters long, it was 75 grammes; and using the coils 16 centimeters long, covering the length of each limb, the pull was 85, clearly showing that, where you have a given length of iron, the best way of winding a magnet to make it pull with its greatest pull is not to heap the coil up against the poles, but to wind it uniformly, for this mode of winding will give you more turns, therefore more ampere-turns, therefore more magnetization. An exception might, however, occur in some case where there is a large percentage of leakage. With club-footed magnets results of the same kind are obtained. It was found in every case that it was well to distribute the coil as much as possible along the length of the limb. All these experiments were made with a steady current. It does not follow, however, because winding the wire over the whole length of core is best for steady currents that it is the best winding in the case of a rapidly varying current; indeed, we shall see that it is not.

EFFECT OF SHAPE OF SECTION.

So far as the carrying capacity for magnetic lines is concerned, one shape of section of cores is as good as another; square or rectangular is as good as round if containing equal sectional area. But there are two other reasons, both of which tell in favor of round cores. First, the leakage of magnetic lines from core to core is, for equal mean distances apart, proportional to the surface of the core; and the round core has less surface than square or rectangular of equal section. All edges and corners, moreover, promote leakage. Secondly, the quantity of copper wire that is required for each turn will be less for round cores than for cores any other shape, for of all geometrical figures of equal area, the circle is the one of the least periphery.

EFFECT OF DISTANCE BETWEEN POLES.

Another matter that Du Moncel experimented upon, and Dub and Nicklès likewise, was the distance between the poles. Dub considered that it made no difference how far the poles were apart. Nicklès had a special arrangement made which permitted him to move the two upright cores or limbs, 9 centimeters high, to and fro on a solid bench or yoke of iron. His armature was 30 centimeters long. Using very weak currents, he found the effect best when the shortest distance between the poles was 3 centimeters; with a stronger current, 12 centimeters; and with his strongest current, nearly 30 centimeters. I think leakage must have a deal to do with these results. Du Moncel tried various experiments to elucidate this matter, and so did Professor Hughes, in an important, but too little known, research which came out in the "Annales Télégraphiques" in the year 1862.

(To be continued.)

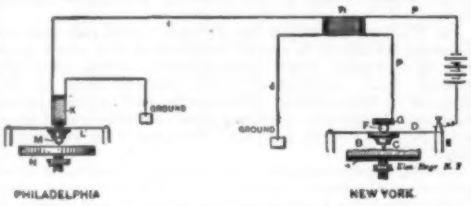
TRANSMITTING PICTURES ELECTRICALLY.

By W. S. EATON.

SOME few months ago in the electrical journals appeared a new method of sending pictures by telegraph. Briefly stated, the process was to divide the picture to be sent into squares, and each square was numbered to correspond with a paper similarly prepared and to be used at a distant point to draw upon, according to the direction sent from the transmitting station by the number communicated.

The example illustrated in the article alluded to particularly impressed the writer with its very mechanical appearance. Every line was necessarily a straight one, and as the outline, only, of the picture could be thus communicated, it seemed to him that the idea, although an exceedingly good one, was altogether inadequate for practical purposes, to say nothing of its utter impracticability as applied to portraits.

When the Bell telephone was brought out as a commercial success, it opened up a vast array of new pos-



TRANSMITTING PICTURES ELECTRICALLY.

sibilities. It was simple enough too; but it is singular, indeed, that these very simple things lie so long undiscovered.

I have apparently digressed from the subject and started to write on telephones, but this digression is more apparent than real, since the method of transmitting pictures electrically, which I shall venture to propose, is based upon principles inseparably connected with telephony.

In order to make clear my idea, I must be permitted, for another brief interval, to depart from electricity and take up the wonderful chemical changes brought about by the action of light in the art of photography.

If we mix in proper proportion bichromate of potassium and gelatine, we get a mixture that is highly sensitive to light. If now we coat a glass plate with collodion and then flow a moderately thick film of the bichromated gelatine thereon, and afterward expose this film to a strong light through a negative, the parts acted upon by the light become insoluble, and those parts protected from the light are easily soluble and capable of being washed out. After a suitable period this gelatine becomes so very hard that it is then possible to take an impression from it in soft metal. This is no discovery of mine; it is an old and much used idea.

To return to the electrical portion again. To transmit pictures electrically between say New York and Philadelphia, we arrange two machines, one at each end of the line and both working synchronously. This, it will at once be evident, is imperative.

We will suppose that we are sending from New York to Philadelphia. A revolving table, A, has mounted upon it a bichromated gelatine film treated as described above. This film is shown in cross section at B. It will be noted that the surface is irregular, corresponding in its elevations to the lights and darks of the picture. It is, in fact, a perfect picture in intaglio.

A tracing point, C, mounted under the diaphragm, D, works, or rather rests, lightly on the surface of the film. The diaphragm is supported at E E, and is connected to one pole of a galvanic battery. F is a platinum contact, and G a carbon button. P P are the primary wires leading to the induction coil, H.

The action will now be easily undertood. The table, A, is slowly revolved, and the diaphragm, D, with its tracing point, C, is fed slowly from the outer edge toward the center. The elevations and depressions of the picture cause the diaphragm to vibrate, and a greater or less current passes through the primary circuit to the induction coil, varying, of course, with the amplitude of vibration of the diaphragm, and its corresponding pressure of the carbon button, G.

The secondary wires, J J, are led one to ground and the other to the distant station to the electro-magnet, K. The varying impulses from the secondary acting through the magnet, K, cause the diaphragm, L, to repeat every movement of the transmitting instrument, D.

In the receiving instrument we replace the tracing point with a lead pencil or other marking device, and stretch upon the table, N, a sheet of paper. The movements of the tables, A and N, are rotary and synchronous. The transverse motions of the tracer, C, and the lead pencil, M, are at the same speed; consequently, with each electrical impulse, we obtain at the receiving station a line either dark or light, as the vibration of the transmitting diaphragm has been great or small, and finally we finish with a perfectly shaded picture, an exact reproduction in chiaroscuro of the original photograph.—*Elec. Engineer.*

NEW ELECTRICAL BOAT.

MR. VAUHAN-SHERRIN'S experiments have lately been directed to certain forms of electric locomotive power, and the results obtained by him are somewhat astonishing. These comprise, among other matters, a special form of primary battery, having a high electromotive force as well as a remarkable maintaining power; a special form of motor of very high power and efficiency in proportion to its weight; and various combinations of these for the purpose of electric locomotion, particularly in relation to the propulsion of launches, tricycles, carriages, cars, etc.

The primary battery used by Mr. Sherrin is a two-fluid battery, in which the anodes are of sheet zinc, and the kathodes are of carbon, specially prepared. In each cell there are three fixed cathodes and two replaceable anodes. Very light plates are used, and the particular construction adopted permits these to be placed very close together, so that the resistance to the flow of electricity internally is very small. The outer cells are of gutta-percha, and in them are embedded the porous cells which surround the anodes. The liquid used in the inner cells is simply water, that placed in the outer cells around the carbon cathodes is a depolarizing liquid of special composition, capable of being produced at a very low cost. It is to this special composition that the cells owe their high electromotive force—nearly two volts each—and their excellent staying power. In one of the tests made by Professor Silvanus P. Thompson, B.A., D.Sc., etc., and mentioned in his able report on Mr. Vauhan-Sherrin's invention, one of these cells gave out an average current of 8·75 amperes for five consecutive hours, with an average electromotive force of 1·88 volts, although the cell was only about half filled at starting. Professor Thompson says that he knows of no battery, primary or secondary, which, for a given gross weight of cell, will yield as great an output, while the economy of zinc is remarkable, the consumption being close to the theoretical limit, and he estimates the net cost of electric energy from such cells at 9d. to 10d. per Board of Trade unit.

The motor is a modified two-pole Gramme machine, having the field magnets constructed in a special manner, which, while maintaining great mechanical strength, admits of perfect lamination of the iron. It is well designed and constructed, and when properly set, is remarkably free from sparking at the commutator. It is also wonderfully light, a one-horse power motor giving only 62 lb. of dead weight.

Of course, the adaptation of this invention to the propulsion of vessels is what we have more immediately to do with, but its value as a motive power for land traveling must not be lost sight of. This is great, and some very satisfactory trials have been made with a Bath chair and a tricycle, fitted with this generator and motor, giving a speed to the latter, when carrying a heavy rider, of about eight miles an hour, and running for nine working hours with one charge at a cost of twopence per hour. The enormous advantages of this means of propulsion when applied to launches are at once apparent, abolishing, as it does, smoke, oil, smell, heat, and coal dust, and taking up but little

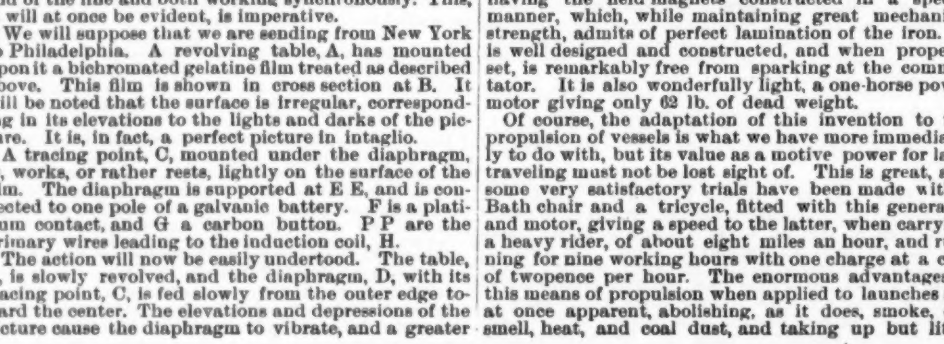


FIG. 1.—LAUNCH FITTED WITH THE VAUHAN-SHERRIN GENERATOR AND MOTOR.

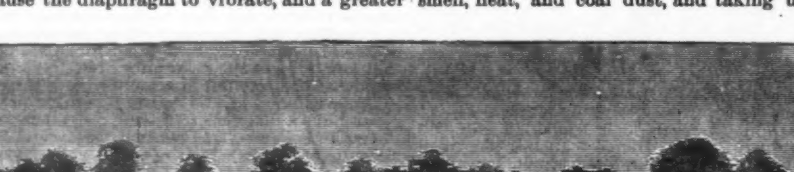


FIG. 2.—PART SECTION SHOWING CELLS, MOTOR, AND MODE OF ATTACHING PROPELLER SHAFT.

A A. Cells. B. Motor. C. Thrust block.

space in comparison with a steam engine, or with an electric engine worked by accumulators. The great nuisance and expense of being obliged, after a few hours' run, to go back to a charging station—as is the case with boats worked by accumulators—for a further supply of power, is totally obviated, as a launch fitted with this invention is a charging station of itself, and can even afford to charge other vessels of the accumulator type whose power has become exhausted. And we may here state that the inventor can carry his generator composition in the form of a paste, which, by merely mixing with water, forms at once a fresh charge for his batteries.

We have seen a launch 40 ft. long, belonging to Mr. Sherrin, and fitted under his system with a capacity for a 600 mile continuous run. On stepping on board there is not the slightest indication of the power driving the propeller. The boat glides smoothly along without noise or vibration, there is no funnel, no smell, everything so clean and sweet that the most elegantly draped lady might spend a week on board without soiling the hem of her garment. The deck and cabin spaces are entirely free from stem to stern, and, as we have said, not a trace of any propelling power is visible save the small box from which the still smaller handles of the regulating levers protrude.

These can put on slow or full speed ahead and, with equal ease, the same astern. The motor is concealed under the deck at the stern, which is tastefully covered with floor cloth, and the generating cells are inclosed under the seats in the same part of the vessel.

In the matter of cost, a launch of the same given size would, if fitted with steam, cost £400; if with the accumulator, £700; if with the "Sherrin," only £250. These figures speak for themselves.

Another and a great advantage following the adoption of this system is that the vessel itself can, from the same motor producing the propelling power, be lighted up throughout, and a bilge pump be worked at the same time, should that be necessary.

Our illustration, Fig. 1, shows a launch fitted with the Vauhan-Sherrin generator and motor, and Fig. 2 a part section of same launch, showing arrangement of cells and motor and the mode of attaching the propeller shaft.

It is said that the knowledge of the powers and uses of electricity is yet in embryo. This we believe. But if we go on like this, we seem to have reached "the parting of the ways," and an important landmark on the road to perfection. This invention of Mr. Sherrin's seems to open up a vista of things to come that may yet upset hitherto accepted axioms, and while there is no doubt at present of the ability of his generator and motor to drive fans, clean knives, work punkas, black boots, drive cycles, mow lawns, turn lathes, drive carriages, propel launches, and generally to perform on a moderate scale every application of power, may we not go some steps further?

Now that the problem of converting electricity into an actual power, without the intervention of accumulators and their attending engines, has become an actual fact, is it presumptuous to dream of the abolition of the steam engine? May we not in the near future see our City of Paris's, our City of Romes, our Teutonics and Majestics crossing the stormy Atlantic without the cumbersome boilers, the elaborate triple and quadruple expansion engines, and large bunkers? Who knows?—*The Marine Engineer.*

TELE-PHOTOGRAPHY.

By HENRY SUTTON.

UNDER various names the problem of transmitting optical images by aid of the telegraph wire has at different times had attention drawn to it.

In putting forward something new in this direction, I will begin by inventing a new name, and propose calling the subject telephany, and the electro-optic instrument the telephane.

The art of telephony is simple compared with that of telephany. In the former we deal with a consecutive series of waves of varying rate and length, and it is the consecutive character of sound waves that lends itself so admirably to electrical translation.

In telephany we are met, at the outset, with a great preliminary difficulty, having to deal with a surface or plane in which the effect appealing to the brain must be observed in all the varying character at one and the same time.

The problem stands thus: a means has to be devised whereby the varying effects on a plane surface are translated into consecutive series of electrical currents, and by means of the consecutive series of currents reconstruct, so to speak, a copy of the original surface; that is, we have to take an optical image, seen as a *surface*, translate it into a *line* of consecutive varying electrical currents, and by means of these produce an effect as a *surface*, having the characteristics of the original image.

We have here two images as surfaces having no time value, and a series of electrical currents having a time value, yet these opposing characteristics are to be presented to the brain as a momentary impression.

Before showing how this apparently impossible problem may be handled, I will explain a probable means for electrically transmitting a photograph.

If we make what photomechanical operators call a *screen* negative of a portrait, using a coarse screen, and from this a photolithographic transfer, transfer it to zinc, and transmit the result by any of the several autographic systems, we have the desired result. In fact, if we apply our knowledge of *half-tone block* making to telegraphy, we are at once in possession of a means of electrically transmitting the photographic semblance of any person.

We may make a *screen* negative, and from that obtain a print on zinc or copper coated with sensitive albumen or bitumen, using the usual solvents, water or turpentine, as the case might be, with which to wash away the unexposed albumen or bitumen, then let the stylus of any autographic system traverse the developed image; the result at the receiving end is a fac-simile portrait. I have used the expression *screen negative*, as it is an understood trade name; as a matter of fact, a *screen positive* would be necessary. We may go further; instead of receiving the facsimile on chemically prepared paper, as in the Caselli autographic telegraph, we can make the receiving stylus perforate thin paper (with the electric spark) by means of a constantly working induction coil, but only put into the receiving circuit by the transmitted current. Place this paper on a lithographic stone or zinc plate, pass a roller charged with greasy ink over it, and we have a *printing surface*, the portrait being *transmitted and reproduced for the printer*, photo-electro-mechanically.

But this is not telephany; the latter must be understood as the means of transmitting images which may be in motion, as seen in a photographic camera, but not in colors.

Having spent some years in studying the problem, I designed the following system five years ago, as my Victorian scientific friends can testify. It may be of much assistance to workers in this direction. I think it offers a fair approximation to the solution of this very difficult problem; at any rate, if in its present form it is not the actual solution, I feel sure it is in the direction indicated by my method that the successful accomplishment of telephany will result.

TRANSMITTER.

L (Figs. 1 and 5) is a photographic objective of the rapid type, producing an intensely illuminated aerial image at A A.

D D (Figs. 1, 2 and 5), light metal disk revolving at a fixed rate of not less than 650 revolutions per minute under the control of La Cour's phonic wheel and fork apparatus as in the Delany multiplex system.

G (Figs. 1, 3 and 5), a glass or other insulated plate, to the front service of which is held, by binding terminals, S_1 S, two triangular pieces of metal just separated from each other, E E.

C (Figs. 1, 3 and 5), a small piece of lampblack, selenium or other substance, the resistance of which may be varied by heat or light. Lampblack compressed is probably the most suitable.

The disk, D D, has a series of small holes, 1, 2, 3, 4, 5, 6, 7, 8, perforated in it, and gradually approaching its center, as a spiral; these holes must be numerous, and yet only one at a time in the field of the image at A A.

R L (Figs. 1 and 5) is the most important part of the transmitter. This I term the regulating lens; it is a lens placed with its plane surface just to receive the aerial image from the objective, L, its focal length being such as to bring all rays reaching it through the perforated disk to a point or focus at C, and therefore its function is to introduce them consecutively to the circuit comprised in S_1, E_1, C, E, S.

Under the influence of this regulating lens the whole image, A A, is allowed to act in consecutive manner, and therefore vary the resistance of C in accord with the lights and shades of the original. We thus solve the big problem of translating the plane image into a line of consecutively varying strength of current, and by bringing C under the influence of the whole image within one-tenth of a second, and during the same time reconstruct our image at the receiving station, persistence of vision will enable us to see the image as one impression.

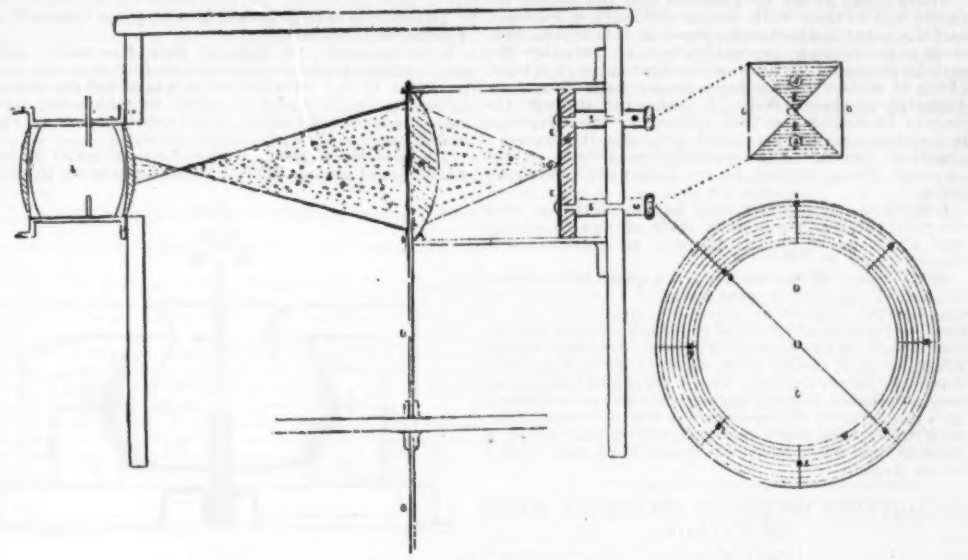
RECEIVER.

S_1 (Figs. 4 and 5), any artificial source of light, a beam of which is by means of lens, L, passed through a pair of Nicol prisms, P, A; this beam reaching lens M_1, is magnified and received by the eye piece, M, M, and viewed by the eye, E. It is absolutely requisite this beam be received by the eye through optical means. The presence of a translucent screen at X, X would be fatal, owing to the delicate nature of the desired effect.

D D (Fig. 4) is a perforated disk, similar to and revolving synchronously with the disk in transmitter.

K K (Figs. 4, 5 and 6), terminals inserted in glass and

TRANSMITTING PICTURES BY ELECTRICITY.



FIGS. 1, 2 AND 3.—TRANSMITTER.

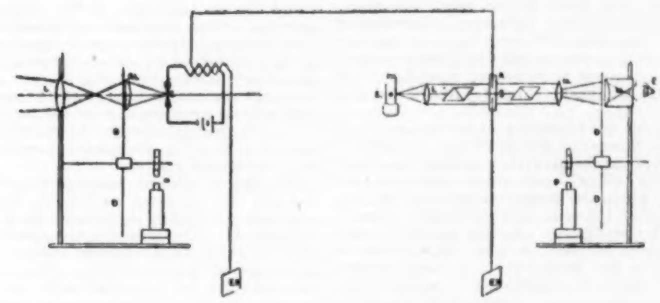
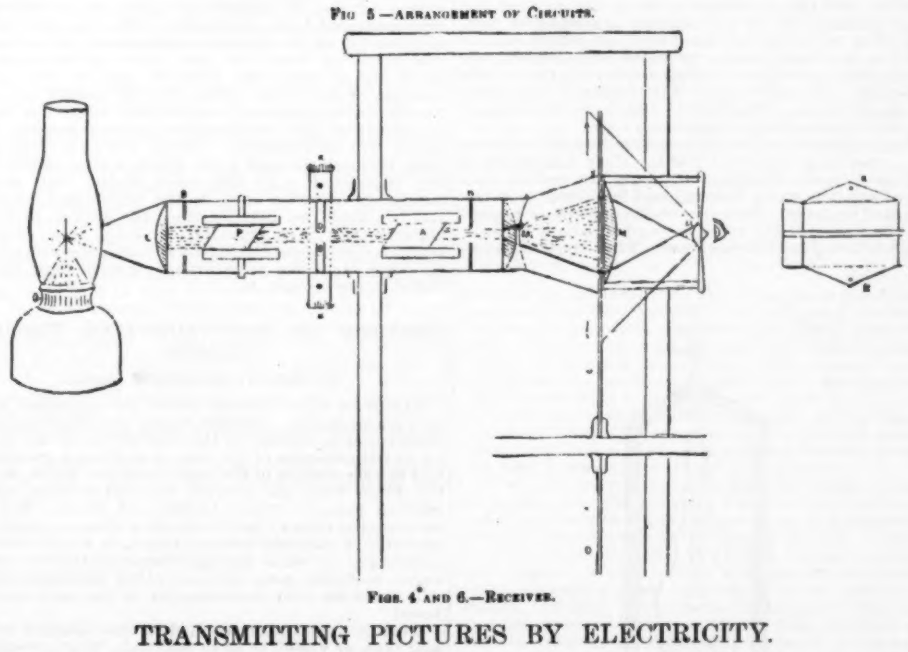


FIG. 5.—ARRANGEMENT OF CIRCUITS.



FIGS. 4 AND 6.—RECEIVER.

having a small space between, holding a drop of bisulphide of carbon, S.

On rotating the Nicol, P, 45°, we reach the position of extinction.

The terminals, K, K, being placed in the secondary circuit of the transmitter—that is, to line—the variable electrostatic strain produced in the drop of bisulphide of carbon under the action of induced currents received from transmitter is to produce variable rotation of the polarized beam, and, therefore, variable quantities of light reach the eye, E.

It is obvious the varying tints will be seen in similar positions as in original image, owing to the synchronous movement of the disks.

The receiver is, then, based on Dr. Kerr's discovery of the rotation of a plane polarized beam of light, through electric stress producing a strain in the medium.

There seems to me no question that the electric impulses will do their work within one-tenth of a second, and the point is whether the stress at O O will be sufficient to produce an observable effect, and whether this may be increased by passing the light through a bisulphide of carbon cell having a longer path of say $\frac{1}{16}$ in. diameter, as shown at Fig. 6, instead of through the drop of bisulphide; so that, conceding the telephane is based on a rightly conceived principle, it becomes a question whether the quantitative results of the physical effects utilized in its design are sufficiently great.

I think the transmitter may be considered as near the right thing as the present state of our knowledge will admit us to reach; there is an appearance of finality about it.

With regard to the receiver it is a question of degree; the actual quantity of light required to reach the eye may be very small when received optically; in fact, so small as to have no power of illumination on a translucent screen; but a quantity of light producing no visible effect on any media, when received by means of an eye-piece, shows a bright disk. Owing to being away from references, I regret my inability at the moment to give the name of the inventor of the revolving disk; with the exception of these disks, the whole design is original, and was devised at Ballarat, Victoria.—*Electrical Review.*

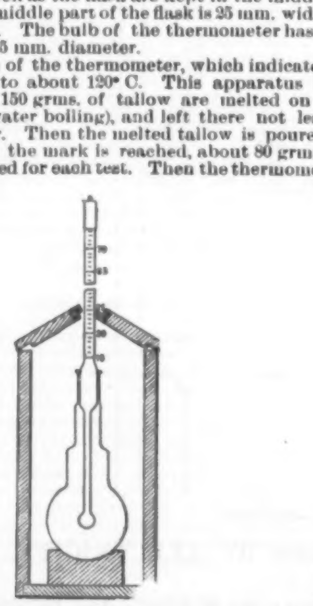
SOLIDIFYING POINTS OF DIFFERENT SORTS OF TALLOW.

By FINKENER.

IN an article upon the determination of the fatty acids of tallow, etc. (see Mitt konig. tech. Versuchs. 1889, 27-41), it is explained that different quantities of tallow used in the tests, and different ways of cooling the melted tallow, change the solidifying points considerably. For comparisons it is therefore essential that the working of the methods should always be the same.

The author used for the following experiments small globular flasks (see figure) of about 50 mm. diameter, and instead of covering them with wadding, to effect a slow cooling of the tallow, he found it a more practical arrangement to place the flasks containing the tallow in a wooden box of 144 mm. in height and 70 mm. in length and width (see figure). In the middle of the bottom is fixed a piece of cork 22 mm. high, with a small hollow in which the flask rests. A thermometer is so arranged as to bring its bulb into the center of the flask. The flask is marked for a determined quantity of tallow, and the thermometer has a rim, so that the tallow is always under the ordinary atmospheric pressure. The top of the box has two flaps, which can be closed as the figure shows, by which arrangement the thermometer as well as the flask are kept in the middle of the box. The middle part of the flask is 25 mm. wide, the upper 12 mm. The bulb of the thermometer has 9 mm. and its tube 5 mm. diameter.

The graduation of the thermometer, which indicates $\frac{1}{8}$° C., should go to about 120° C. This apparatus is used as follows: 150 grms. of tallow are melted on a water bath (the water boiling), and left there not less than half an hour. Then the melted tallow is poured into the flask till the mark is reached, about 80 grms. of tallow being used for each test. Then the thermometer is put into the tallow and the flask placed in the box, as described above. Every two minutes the temperature is noted, the solidifying point being arrived at either when the temperature remains constant for some minutes or when it ceases to fall and rises again a little; in the latter case the highest point of the rising is the solidifying point.



THE SOLIDIFYING POINTS OF TALLOWS.

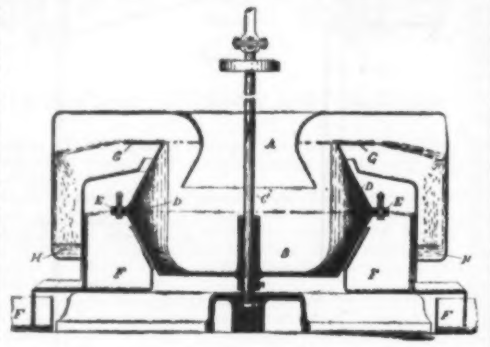
The time necessary for the entire test is two hours, for the cooling alone about one hour. In working with three apparatus at the same time, three tests can conveniently be made in three hours. After the test the tallow is melted again in boiling water, the flask emptied and cleaned with a little ether. The author has made experiments with different sorts of tallow with this apparatus, and has ascertained what effect alterations in the described details of making the experiments have upon the temperature of the solidifying points. If different maximum temperatures (from 50° to 100° C.) are applied in melting the tallow on the water bath, the experiments show that the solidifying points become lower with the rising of the maximum temperature, but that they always become alike for the same sort of tallow after it has been heated to 100° C. for half an hour. Further heating does not affect the test. At ordinary temperatures this result is not changed, but if the temperature of the testing room is low (about 10° C.), a further reduction of 0·2° C. takes place. It is of no importance at what temperature of the tallow the flask is placed in the box, provided that such temperature is at least 10° C. above the solidifying point.

SEPARATION OF FINELY DIVIDED MINERAL OR METALLIC MATTERS.

THIS device is by James C. Newbery and Claude T. J. Vautin, of London.

It is designed to dispense with the use of ordinary settling tanks or reservoirs or filtration for such purposes by the substitution of a modified centrifugal apparatus running at high speed, by which the separation in strata of various mixed substances is effected in the order of their respective densities.

The centrifugal action causes the particles of matter which are of greater density than the solution to press



outward as far as possible to the periphery of the centrifugal machine, leaving a clear solution between it and the central axis of the apparatus. This clear solution is then regularly withdrawn either by siphonage through a siphon pipe or through a suitable opening and collected by external troughs about the periphery, while the constant supply of the mixture is similarly maintained through the supply pipe. As the solid matter accumulates at the periphery it is allowed to escape through a suitable opening in the top, bottom, or side of the periphery, so as to keep the apparatus in constant action.

The mixed mineral substance and liquid is poured through the central orifice, A, into the centrifugal machine, B, which is rotated at a high speed upon the axis, C. The mixed mineral substance and liquid will by centrifugal action collect, as at D, at the periphery of the apparatus. The periphery of the apparatus may be provided with orifices controlled by shutters or with apertures controlled by spring-pressed valves, or may be divided by a joint, E, controlled by spring-pressed bolts, as shown. The pressure of the solid matter of the mineral substance at the periphery will serve to force the two parts of the machine, apart and to open the joint, E, against the spring reaction of the bolts, which may be readily adjusted to any desired pressure consequent upon the speed of revolution and the weight of mineral matter. This action will automatically release the semi-fluid solid mass through the said joint, which is then collected in the troughs, F. As the solid matter will always occupy an exterior zone in the centrifugal machine, and the liquid an interior zone, the supply of mixed material may be so regulated that the inner zone of liquid is discharged through a suitable opening or over the edge, G, of the apparatus, and may then be collected in the trough, H.

PROCESS OF DISINTEGRATING FIBROUS PLANTS.

By HENRY HARRISON DOTY.

RAMIE or other fibrous plants are subjected to an acid fermentation. By this means the degumming or deglutination thereof, or the destruction of the tenacity or adhesiveness of the gum or glutinous substances and the separation of the bark from the fibers and of the fibers from the internal ligneous portion, can be effected without injury to the said fibers. For this purpose the rhea or ramie or other fibrous plants are placed in a suitable tank or vessel, in which they are submerged in water having dissolved therein brown sugar, molasses, cane juice or other substance which will cause an acid fermentation in the said tank or vessel.

Heat is, if necessary, applied to the solution in the said tank or vessel, so as to maintain it at a temperature of about from ninety-five to one hundred degrees (95° to 100°) Fahrenheit. In connection with the acid fermentation the process includes a subsequent treatment of the fibrous materials with petroleum or other hydrocarbon.

In the accompanying drawings, Fig. 1 is a plan of an apparatus preferably employed for carrying on the process herein described, the cover of the tank being removed.

Fig. 2 is a side elevation of the said apparatus, partly in vertical central section.

A is a reservoir or tank of suitable dimensions, which is provided with a movable cover, B, and with a draw-off cock, C.

D is a coil formed of a tube of copper or other suitable metal, the extremities of which are inserted into the said tank, A, one close to the bottom thereof and the other as high up as may be convenient, both extremities of the tube being left open to permit free communication between the said tank and the coil. The coil, D, is preferably wound so as to leave a space of say half an inch between the convolutions thereof. In or upon the lower convolution of the coil is arranged a grate or fire bars, D', or the said coil is placed upon a suitable grate. On the said grate coke or coal or other fuel is to be placed for heating the said coil, the supply of air necessary for the combustion being admitted through the spaces between the convolutions of the coil and through the said grate, or other means are provided for heating the water in the tank when necessary. For example, it may be heated by a jet or jets of steam. A jacket or casing, D², of sheet metal or other suitable material is provided around the coil, D, to protect it from the weather and to concentrate or confine the heat, the said jacket or casing being provided with suitable holes to admit the air necessary for combustion.

To provide for maintaining the temperature uniform throughout the liquid in the tank, two or more tubes or water ways, E, are arranged at the bottom of the tank, A. These tubes or water ways, E, are connected at one end with a receptacle or chamber, F, inclosing the lower or inlet end of the coil, D. The said tubes or water ways, E, diverge from each other and extend to the corners and opposite side of the tank, A. The ends of the said tubes or water ways, E, are open.

In some cases I treat the material in pits or in indigo vats or the like. To provide for maintaining a uniform temperature throughout the liquid in such cases, it may be advantageous to employ a pump so arranged that when the surface of the liquid becomes heated by the temperature of the atmosphere and by the sun's rays, the colder liquid can be drawn from the bottom of the vat or pit and discharged over the surface of the liquid.

The treatment of the rhea or ramie is as follows—that is to say:

The said rhea or ramie, preferably in the green state, as gathered, is made up into bundles or bales, which are placed in the tank, A, care being taken not to place therein too large a quantity of the material, having regard to its increase in bulk when wet. The said bundles or bales are preferably arranged in layers, so that the bundles and bales in one layer are at right angles to those in the adjacent layer or layers, sufficient spaces being left between the bundles or bales to permit the free circulation of the liquid. To keep the bundles or bales submerged, they may be covered with wood gratings, bars, or boards on which are placed weights of stone or other suitable material. The tank is then filled, or nearly filled, with water, preferably cold water, as this facilitates the setting free of the gum or glutinous substances by the subsequent acid fermentation. Brown sugar, molasses, cane juice, or other suitable material that will produce or set up an acid fermentation is then added in the proportion of about from one half to one and a half ($\frac{1}{2}$ to $1\frac{1}{2}$) ounces of brown sugar or the like, to each gallon of water. The cover, B, is then placed upon the tank, A, and a fire is lighted in the coil, D, and is kept up for three or four days, more or less, the temperature of the fluid being maintained at from ninety-five to one hundred degrees (95° to 100°) Fahrenheit, or thereabout.

Upon the application of the heat to the coil, D, a rapid upward current will be induced in the said coil, the cold liquid flowing from the bottom of the tank, A, through the tubes, E, into the lower extremity of the coil, and after having its temperature raised in the said coil being discharged therefrom into the upper part of the said tank. The material under treatment is examined from time to time, and when it is found

Fig. 1.

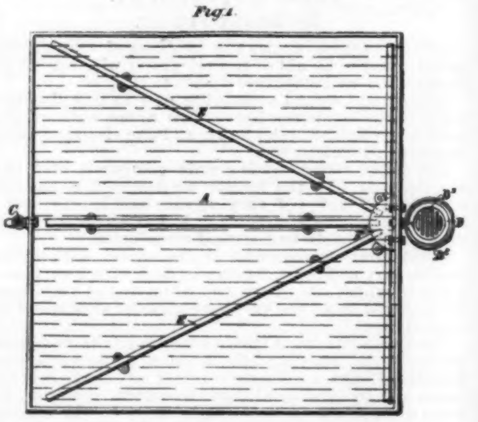
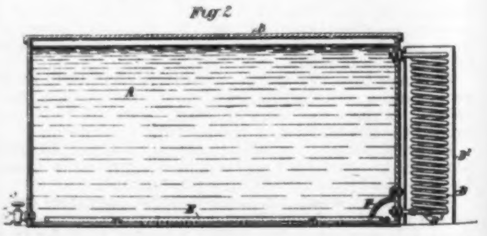


Fig. 2.



that the bark is sufficiently loose to readily separate from the fibers and internal woody portion the bundles or bales are removed from the tank, the bark and fibers are stripped from the stems and the said fibers are well washed in clean water and then spread out in the open air to dry, or they may be dried by artificial means and treated like flax. The said fibers are then treated in a closed tank with naphtha, petroleum or other hydrocarbon either in a liquid state or in a form of vapor, whereby the said gum will be dissolved. The said gum and naphtha or petroleum are then removed by means of a heated solution composed of about one part of crude carbonate of soda or of soft soap to forty parts of water. The fibrous material is then rinsed with water or washed with common soft soap or with soft soap and petroleum in, or about in, the proportions of one part of petroleum to sixteen

parts of soft soap. The said material is boiled in this preparation for about one hour, more or less. This treatment is also very advantageous for bleaching the material. The material is then rinsed and dried, ready for the machinery and other appliances for treating it preparatory to its use for industrial purposes.

The improved process above described is chiefly designed for treating the rhea or ramie or other fibrous plants in a green state, but it is also advantageous for treating the same or the fibers thereof in a dry state.

Among the fibrous plants which can be advantageously treated by the improved process may be mentioned flax, hemp, and the leaves of the pineapple and banana.

In treating *Phormium tenax*, or New Zealand flax, and similar plants it may be necessary or desirable to slit or tear the leaves longitudinally to expose the gummy portions before subjecting them to the acid fermentation as above described.

Hemp and flax can by the process above described be thoroughly retted in from five to seven days, and may be subsequently treated in the ordinary manner.

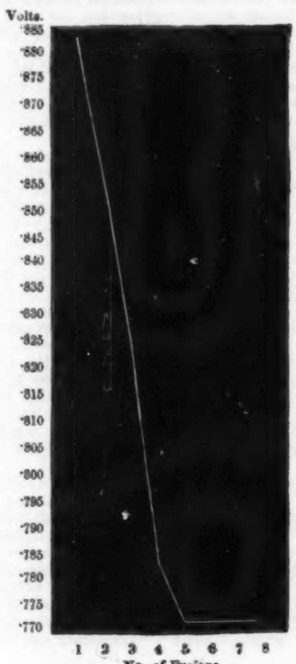
The fibrous material treated as above described is applied to the manufacture of textile fabrics, to rope making, and to other manufactures.

In treating grasses which have their fibers surrounded with bark the said bark should be stripped from the fiber when wet, and the fibers afterward removed from the woody portion.

THE CHANGES OF PROPERTY OF AMALGAMS BY REPEATED FUSION

By Dr. G. GORE, F.R.S.

IT is well known that various alloys undergo a change of properties by repeated melting and cooling. Having found during some experiments made for examining the changes of volta-electromotive force of alloys during fusion that an amalgam composed of 1 part by weight of cadmium and 4 of mercury gave different results after each successive melting, notwithstanding that the chemical composition of the substance remained unaltered, I took a freshly made bar of the substance and a strip of sheet platinum and formed a voltaic couple with them in a solution composed of 1 part by weight of common salt and 100 of distilled



CURVE SHOWING EFFECT OF REPEATED FUSIONS ON Cd AMALGAM.

water, and ascertained the fixed amounts of deflection it produced of the needles of an ordinary torsion galvanometer of 50 ohms resistance after different numbers of fusions of the amalgam; they were as follows:

Number of Fusions.	Deflections.
1	29
4	24
8	11
12	12

The differences of strength of current were manifestly due to the fusions, and not to any loss of mercury or oxidation of the cadmium. The amalgam melted at 98° C., and was not on any occasion heated above 130° C. There was no visible fume or sublimate caused by volatilization of the mercury, and it was found in a separate experiment that a diminution of as much as 20 per cent. in the proportion of mercury produced only about one degree difference of deflection of the needles.

I took a second freshly made bar of the same substance, and measured the electromotive force of the couple in the same electrolyte at 17·5° C. after each fusion and cooling, by the method of balance, with a suitable thermoelectric pile (see Proc. Birm. Phil. Soc., vol. iv., p. 130; *The Electrician*, vol. xii., March 15, 1884, p. 414), and obtained the following results:

Number of Fusions.	Volts.	Number of Fusions.	Volts.
1	0·8809	5	0·7724
2	0·8553	6	0·7724
3	0·8267	7	0·7724
4	0·7838	8	0·7724

The annexed diagram shows the curve of the change.

In order to ascertain whether the alloy changed in property spontaneously, a third freshly prepared bar was kept in a horizontal position and examined daily with the help of the same electrolyte and galvanometer.

The following permanent deflexions were obtained:

Number of Days.	Deflections. Deg.	Number of Days.	Deflections. Deg.
1	18	6	7·5
2	10	7	6·5
3	10	8	7·5
4	7·25	9	7·0
5	8·00	10	6·0

At the first moment of immersion of the couple each day the amount of temporary deflection was about 30° and the above numbers are the amounts of permanent deflection produced at the end of three minutes. The bar was wiped dry after each experiment, and no error was produced by oxidation; and as a large bulk of the liquid was employed, the diminution of amount of fixed deflection was not due to exhaustion of the solution. The diminished electromotive force indicated a spontaneous molecular change going on in the amalgam during the first few days.

In order to find whether the amalgam altered in volume by repeated fusion, the specific gravity of a freshly made piece was taken after the first and sixth fusion. The substance was melted under water, and no loss of weight or oxidation occurred during the process.

After the first fusion the specific gravity was = 12·5438 at 14·5° C.

After the sixth fusion the specific gravity was = 12·6190 at 14·5° C.

From the various results obtained in this research and from other considerations, I conclude that this amalgam, by the act of fusion and subsequent cooling and by spontaneous change, suffers a loss of molecular motion, potential heat, chemical activity, voltaic energy, diminishes in volume, and becomes less corrodible in a solution of chloride of sodium. The changes appear to be permanent.

It is evident that the method employed, viz., measurement of volta-electromotive force, may be used for detecting and measuring physical changes produced in alloys by repeated melting, lapse of time, etc.—*Phil. Mag.*

THE USE OF TANNINS TO PREVENT BOILER CRUST.

By M. LEO VIGNON.

THE form of deposit which is left in a boiler by the evaporation of the water is of considerable importance, as affecting the economy and safety of its action. When the residual matter is deposited as a fine mud which can easily be removed, the boiler can be used more economically, lasts longer, and is safer than when the deposits form hard crusts on the sides, which can only be removed by knocking off with a hammer.

Chemical substances are largely employed to prevent the formation of such hard crystalline deposits, but it must be said that most of these are quite inefficacious, and are based upon erroneous principles.

It is quite irrational to apply a single solution or preparation in the same manner to prevent crust in boilers fed by waters of different composition. Some of these preventives even can only exert their action at the expense of the material of the boiler itself.

Having been led to examine a number of mixtures sold for this purpose, I have found that many of them consist of aqueous solutions of tannin and sodium carbonate. One among them had the following composition per liter:

Extract of sumac, 30°	260 c. c.
Dry sodium carbonate	160 grms.

Sometimes the sumac extract is replaced by that of chestnut.

It is difficult to imagine what part the tannins can play in the prevention of boiler crust; but it appears, upon consideration, that, owing to their coloration, and the amount of extractive matter they contain, they are simply employed to disguise the real nature of the solution; they serve to complicate the analytical examination of the solution, and to puzzle any chemist sufficiently bold to wish to discover their secret.

It appears, however, from a chemical point of view, that the tannin can scarcely be without action on the plates of the boiler. If the tannin is free, its acid properties will lead to the solution of a certain amount of iron. In presence of carbonate of sodium, it is to be feared that it will absorb oxygen and lead to the oxidation of the iron.

Guided by these ideas, I made the following experiment:

Five bits of iron plate, measuring 15 centimeters long, 5 wide, and 0·2 thick, were well cleaned and weighed:

No. 1	100·420 grms.
" 2	94·450 "
" 3	98·250 "
" 4	103·450 "
" 5	98·600 "

The following solutions were then made up in four porcelain basins:

1. Rhone water	1,500 c. c.
2. Extract of sumac, 30°	35 "
3. Sodium carbonate	15 grms.
4. Extract of sumac, 30°	35 c. c.
Sodium carbonate	15 grms.

Nos. 2, 3, and 4 were made up to 1,500 c. c. with Rhone water.

Solution 2 was acid to litmus paper; solution 4, alkaline.

One piece of iron was retained for comparison, the other four being placed in the four solutions and boiled for four successive periods of two hours each, the bulk of the solution being kept constant by the addition of distilled water. Each plate was thus exposed to the boiling solution for eight hours.

At the end of this period the following observations were made:

1. *Rhone water.*—The iron was slightly rusted; the bath contains a deposit of calcium carbonate, slightly tinted by oxide of iron.

2. *Sumac extract.*—Iron covered with a blackish coating possessing the properties of tannate of iron. The baths show a dark coloration.

3. *Carbonate of sodium.*—The iron has no trace of rust. The bath contains a slight deposit of pure white calcium carbonated, untinged by oxide of iron.

4. *Extract and carbonate.*—Iron covered with a slight film of tannate; solution very black.

The four pieces of iron were washed, brushed, rubbed with fine sand, and then dried and weighed.

	Weight. Before experiment.	After.	Loss.
1. Rhone water	100·420	100·370	0·050
2. Sumac extract	94·450	93·507	0·934
3. Carbonate of sodium.	98·250	98·245	0 005
4. Sumac extract and carbonate of sodium	103·450	103·070	0·380
5. Original plate	98·600	98·590	0·010

These results show with the greatest clearness:

1. That free tannin attacks the plates of a boiler.

2. That tannin associated with an excess of sodium carbonate has the same disadvantage.

3. That sodium carbonate has practically no action on the plates.

Solutions containing tannin should, therefore, on no account be used, as they tend to attack the boiler plates; whereas, sodium carbonate, added in the proportion found necessary by analysis of the water, presents no disadvantages whatever.—*Journal de l'Eclairage au Gaz.; Chem. Tr. Jour.*

THE WILDE AND REYCHLER CHLORINE PROCESS.

PROFESSORS WILDE & REYCHLER, of Brussels, have lately been able to form an estimate of the value of their new process for the preparation of chlorine, not only from their own laboratory experiments, but from a systematic trial of a complete plant which has been erected at the works of MM. De Naeyer et Cie. This trial leads them to believe that their process has many economical advantages over the older processes of Weldon, Deacon and Pechiney.

The new process is based on the decomposition of hydrochloric acid in the following conditions: When equivalent weights of crystalline magnesium sulphate ($MgSO_4 7OH_2$), magnesium chloride ($MgCl_2 6OH_2$), and manganese chloride ($MnCl_2 4OH_2$) are heated together, they first dissolve in their water of crystallization and then give off hydrochloric acid gas, leaving a pink hydroscopic mass consisting of a mixture of magnesium sulphate, manganese chloride, and magnesium oxychloride, entirely free from water. When heated to a dull redness in a current of air in a muffle, this mixture evolves a further quantity of hydrochloric acid gas and chlorine, and leaves a black porous residue containing magnesium sulphate and a magnesium manganite of the composition $Mg_2Mn_3O_8$. The porous lumps formed in this way are introduced into an earthenware tube surrounded by a thin iron sheeting, and are heated to a temperature of about 450° C., either directly or by means of a regenerative furnace. This tube is connected with two iron tubes, through one of which hydrochloric acid gas is led after it has been treated in a separate furnace, and through the other a current of air passes which has also been heated to the same temperature. The further end of the cylinder has also a tube attached to it which carries off the chlorine gas produced in the cylinder by the joint action of the air and hydrochloric acid passing over the heated magnesium manganite. The plant necessary for heating the gases introduced into the cylinder in which the reaction takes place has no special form; in fact, any plant at present in use for heating air of a blast furnace can be used. The part played by the magnesium sulphate in the reaction, other than that of preventing the fusion of the mass, and thus maintaining its porous nature, is not known. Apparently the change that takes place consists in the alternate chlorination and oxidation of the magnesium manganite. These changes may be theoretically expressed by the following equations:

(1) $Mg_2Mn_3O_8 + 16HCl = 3MnCl_2 + 3MgCl_2 + 4Cl + 8H_2O$.
(2) $3MnCl_2 + 3MgCl_2 + 8O = Mg_2Mn_3O_8 + 12Cl$.

In practice, however, the above reactions go on simultaneously, and the hydrochloric acid gas is not entirely decomposed, there always being a small percentage of this gas in the gases passing out of the cylinder in which the reaction takes place. The authors have investigated the conditions under which the maximum yield of chlorine is available, and have found that it not only varies with the temperature of the reacting compound, but depends also on the relative amounts of hydrochloric acid gas and air, and the rate at which the mixed gases pass through the cylinder.

It will be noticed that although the process is an alternating one, yet chlorine is evolved at both stages, and that therefore the method may be considered to be just as continuous as the Deacon process. Our readers will remember that the Brin's oxygen process, as now worked, offers a similar example of two alternate reactions taking place apparently at the same temperature. It may, however, be found more economical to employ two cylinders so heated that one shall be in the chlorinating stage while the other is in the oxidizing stage, and thus secure a constant rate of production of the chlorine gas. The inventors point out that the cost of fuel and of labor is less than in the Deacon process, and the plant is much simpler than that used by the Pechiney method. The manganite is found not to require renewal for a long while, and then only a little is needed at a time, and the high percentage of chlorine in the gas which is evolved renders it possible to prepare directly therefrom bleaching powder of high chlorine content. The plant erected at MM. De Naeyer et Cie.'s works has now been at work some time, and has proved capable of continuously decomposing 76 per cent. of the hydrochloric acid used, and of the remainder four-fifths have been recovered and utilized in the process.—*Industries.*

ANTIQUE DIAMOND DRILLS.—Mr. Flinders Petrie has advanced the theory that the Egyptians used diamond drills. He cites six examples in the Boulak museum and at Gizeh. In the temple at Gizeh there is a drill hole with the core sticking in it.

SITTING BULL.

FOR some time past, not only in Dakota, but also throughout the vast regions of the northwestern part of the United States, considerable unrest and agitation has prevailed among the Indian tribes. It is alleged that a messiah has appeared who will deliver the red man from the tyranny of the whites, and the "braves" have also been whetting their warlike propensities by indulgence in ghost dancing. As we stated recently, bad treatment on the part of the American government and people is the exciting cause of this discontent. At all events, this is the view put forward by the Indians themselves. The other day a Roman Catholic missionary visited the hostile camp at Pine Ridge, and the Indians told him how the Great Father (President Harrison) had cheated them out of their rations, and had broken solemn promises by moving them from the territory allotted to them.

Sitting Bull, a Sioux Indian, was born in 1835. In his youth a noted hunter and warrior, in early middle age he gained influence and followers as a medicine man and counselor, besides being a bitter hater of the whites. After the Little Big Horn massacre of 1876, he retreated into British territory, and from thence made frequent raids. But, as his followers gradually diminished, he surrendered himself to the Americans, and after an imprisonment of two years was released. He is stated to be an active fomenter of the present discontent. Our engraving is from a photograph by Barry.—*The Graphic.*

SITTING BULL.

THE EFFECT OF THE PRODUCTS OF HIGH EXPLOSIVES, DYNAMITE AND NITROGLYCERINE, ON THE HUMAN SYSTEM.

By THOMAS DARLINGTON, M.D., Surgeon to Copper Queen Consolidated Mining Company and Arizona Southeastern R.R. Co. Hospital.

IN the construction of any work of magnitude, in the present day, involving the removal of rock, dynamite or nitroglycerine is used in considerable quantities.

When these are used in open cut work, as on railroads, after the explosion the gases immediately distribute themselves in the atmospheric air, and no effect has been noticed on the workmen employed.

But where used in tunnels, as in mining or other partially closed cavities, and the gases or residue are slow to escape from the mouths of the tunnel, or an up air shaft, serious deleterious effects are produced.

Dynamite is composed of nitroglycerine with some absorbent. There are for purposes of study practically two classes of dynamite, which might be termed inorganic and organic, according to the absorbent used. As a type of one class is that made with infusorial earth—kieselgur—which is composed of siliceous diatoms, and of the other, that made with ground wood pulp, or sawdust. Others, still, are made from a combination of both kinds. The results of the explosion, however, are practically the same in either case, except with the organic absorbent we get with the products an additional amount of carbon.

An experience of over five years where such explosives have been in use, and as yet not having read any article on this subject, has led me to believe that one might be of interest to some of the profession.

During 1885 to 1887, while surgeon to the New Croton aqueduct, fully thirteen hundred cases of asphyxia or partial asphyxia, and poisoning, from the products produced by the explosion of dynamite, came under my care; and more recently a few other cases which I have had a better opportunity to study.

Two classes of cases were observed: First, where a considerable quantity of the products was inhaled at one time—acute cases; secondly, where the men constantly breathed a small amount, or chronic cases. The acute cases varied according to the amount inhaled.

In some cases, where the amount of dynamite used is not large, or where after the explosion a considerable quantity of fresh air has been mixed with the products of combustion, or where the workman has, after a few breaths, become giddy, and is pulled away by others and sent to the surface, the effects produced are a trembling sensation, flushing of the face, succeeded sometimes by pallor, frequently nausea, sometimes vomiting, with throbbing through the temples and fullness in the head, as if it would burst, followed by an intense headache characteristic of poisoning by nitrites—similar to that of nitrite of amyl—only not so violent, but more persistent, frequently lasting forty-eight hours. The heart's action is increased, and the pulse full and round, though somewhat compressible.

CASE I.—J. C——, occupation miner, while returning to work after a blast, became dizzy, and crawled on hands and knees back to the bucket; felt as if drunk. About twenty minutes afterward was nauseated and vomited slightly. Had a feeling as if his head was swelled. After vomiting, the headache increased. The pulse at this time was full and bounding, and 108. Ten hours afterward the headache was more pronounced, and the pulse 88 and more compressible.

Where, however, a man goes into the tunnel immediately after the explosion, and is brought in contact with a large percentage of the poisonous materials, the effects are giddiness, immediately followed by unconsciousness, and the patient presents the usual appearance of asphyxia. Sometimes in these cases the pulse is full and bounding, though very compressible; but in most of the cases it is alarmingly weak. Generally there is great pallor, though this may be partially due to working underground. The comatose condition soon passes away, and is succeeded by drowsiness, languor, cold perspiration, intermittent pulse, and generally nausea and vomiting. Sometimes the breathing is spasmodic, and frequently there is hiccough, and after a time severe headache.

Nearly all of these cases, however, no matter how serious they seem at time, recover; though a substitute on the aqueduct, during my absence, was on one occasion so unfortunate as to lose two cases. I found upon inquiry that death in these cases occurred several hours after the patients were removed from the tunnel, and was due to paralysis of respiration.

In the chronic cases there are four prominent symptoms: Headache, cough, indigestion, and disturbances of the nervous system.

The cough is similar in character to the cough of pertussis or of malaria, and at first I was under the impression that it was purely malarial, as cases of intermittent fever were frequent. But although some of the cases may have been complicated with malaria, there were many others that were not, in which the cough was persistent.

In nearly all the cases there was a continuing headache.

Next in prominence to these symptoms come disturbances of the nervous system, as trembling, irritability, neuralgia, etc. In fact, nearly if not all of the symptoms were attributable to this cause. Even the cough, in all probability, was due to the effect produced on the pneumogastric nerve.

One of the superintendents became so nervous and irritable, largely from this cause, that it was with difficulty that he could get along with the men. All of the men affected seemed extremely nervous. And with this was associated indigestion, probably due to the same cause. Of course, with this latter symptom, the character of the food and the manner in which it was eaten must be taken into consideration. But as soon as a man with these chronic symptoms was taken from the tunnel and placed at work on top, he steadily improved, and would finally recover entirely.

It was also noticeable that those who had previously suffered from dyspepsia or neuralgia were made much worse by the dynamite smoke.

One inspector on the aqueduct was forced to resign by reason of the constant return of an old "tic douloureux," due to this cause. What were the symptoms recognized due to?

The formula for nitroglycerine is $C_3H_5(NO_2)3$. And the products from the combustion of those are written: $4(C_3H_5N_3O_9) = 10(H_2O) + 12(CO_2) + 6(N_2O_3)$.

In other words, the products are water, carbonic acid gas, and nitrogen dioxide; none of which would produce the symptoms above described except asphyxia, but not the effect on the heart, nor the other symptoms witnessed. What then was the cause?

A comparison of the above symptoms in the acute cases with the phenomena produced by various sized doses of nitroglycerine shows them to be identical. This similarity of symptoms from inhalation of the products of the explosion of dynamite, and of those produced by the nitroglycerine itself, is so well marked that even miners themselves have noticed it. Frequently when dynamite is frozen a miner will place a cartridge in his boot to thaw it out; and the absorption of nitroglycerine through the skin will produce precisely the same symptoms as in the mild acute cases of the inhalation of the products before described.

Again, I know an instance where a miner used his knife to cut a cartridge, and afterward cut and ate an apple with same knife. In this case, according to his statement, the symptoms were similar to being "knocked out by the powder smoke," only more severe. The headache persisted three weeks. And on another occasion this same miner cut up some tobacco to smoke with a knife that he had used for dynamite, and was again similarly affected. Here the heat from the tobacco inhaled smoke volatilized the fine particles of nitroglycerine on the tobacco below, and poisoning was produced by absorption through the lung tissue.

No other conclusion can well be reached than the fact that there is mixed with the gases produced unexploded particles of nitroglycerine in a volatile state; and these particles inhaled by the miners produced the effect described.

There is no doubt but that the explosion of a large quantity of dynamite would produce sufficient gases of CO_2 and N_2O_3 to produce asphyxia. Here we get the cyanosis and other symptoms of simple asphyxia, and we may get nausea and vomiting; but not the same disturbance of the sympathetic system, nor the continued chronic spasms of the vagus, nor the persistent headache pathognomonic of nitroglycerine poisoning. This fact can be conclusively proved by waving in the fumes, immediately after an explosion, a cold sheet of glass, and thus collecting upon it by condensation a small percentage of the nitroglycerine itself.

As regards treatment—as a preventive, the use of such apparatus or machinery, whether by blowing or by sucking, as will rapidly clear the tunnel or cavity from noxious gases or fumes is to be recommended. Where steam drills that are worked with an air compressor are used, they contribute largely to this end.

Also, it has been found by makers of dynamite that the use of a large cap will explode a greater percentage of the glonoine than a small one, and this to a certain extent obviates the trouble. In certain cases, however, for some reason, a cartridge does not explode, but burns like a candle, with considerable spluttering. In such an instance the amount of nitroglycerine volatilized is much greater than if exploded, and consequently the effects far more deleterious. I have witnessed a whole "shift" "knocked out" from this cause.

Of course, such measures as are generally used in cases of asphyxia are of service. But in addition to these, the use of cold to the head, and of atropine, ergotine, or other vasomotor stimulants, administered subcutaneously, are of necessity indicated and exceedingly efficacious. There is little doubt that the effects of nitroglycerine are produced from its decomposition and the formation of a nitrite in the body. "Treatment with ammonia restores normal color and normal functional power to nitrite-poisoned blood."

Acting on this principle, and from its stimulant properties, I have uniformly treated my cases with inhalation of ammonia, and also given the carbonate and aromatic spirits of ammonia internally; and up to the present time have not lost a case.

It seems to me it would be well for those in charge of such works to recommend to the workmen to carry with them small vials of this remedy for use in similar cases.

In none of the cases did I notice any changes in the blood—that is, darkening—such as are mentioned in nitroglycerine poisoning, but this may have been due to lack of proper observation on my part. In numerous cases of pneumonia the sputum was darker than usual, but this I attributed to the dust and lamp smoke inhaled.—*Medical Record.*

MYOPIA.

AT a recent meeting of the Paris Academy of Medicine, M. Motais, of Angers, maintained that myopia, or short-sightedness, is one of the products of civilization. An unexpected proof of this view was found in the condition of the eyes of wild beasts, such as tigers, lions, etc. M. Motais, having examined their eyes by means of the ophthalmoscope, discovered that animals captured after the age of six or eight months are, and remain, hypermetropic, while those who are captured earlier, or, better still, born in captivity, are myopic. This short-sightedness is evidently induced by artificial conditions of life.

THE OSCHANSK METEORITE.

THE collection of the Museum of Natural History has recently been enriched with a curious specimen of a meteorite. The phenomena that accompanied its fall, as well as the intimate character of its composition, make it a most interesting object.

The fire ball whence the stone fell was observed in Russia, over a large extent of territory, on the 18th of

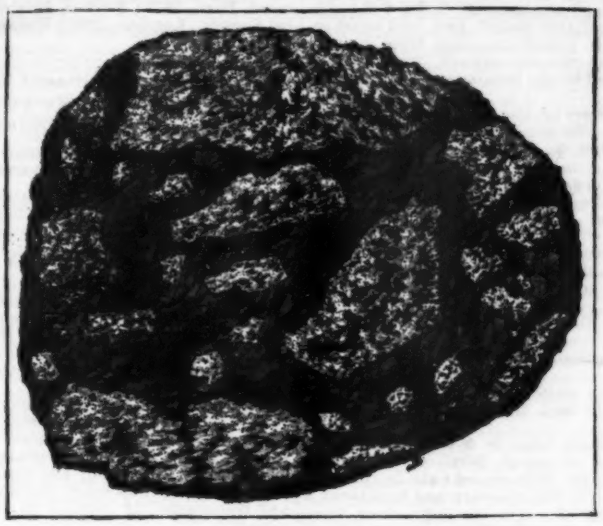


FIG. 1.—FRAGMENT OF OSCHANSK METEORITE.

August, 1887. We have testimony from various points of the southwestern part of the government of Perm, and the government of Viatka, principally from the districts of Perm, Oschansk, Kungur, Osos and Sarapul. Between Perm and Oschansk, according to an inhabitant, there appeared toward noon, in a very clear sky, a nearly horizontal train of fire that emitted flashes on its route, along with detonations more like the discharge of musketry than like a thunder clap. Shortly afterward there fell upon the earth a shower of incandescent stones that became black upon cooling and that buried themselves at different depths in the earth. These were numerous and weighed from 2 to 70 pounds. It may be imagined what terror and what fables so un-

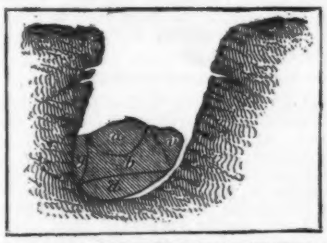


FIG. 2.—TABOR METEORITE BURIED IN THE EARTH AFTER ITS FALL.

a, the largest (315 lb.) fragment; *b*, part removed by the public; *v*, gray portion; *g*, a 4½ lb. piece; *d*, small fragments.

usual an occurrence will engender among people. A professor of the Perm Seminary, Mr. Selivanov, made a sketch of the wonderful spectacle, which we reproduce in Fig. 3. He has written a description from which we extract without much change the following passage: On the 18th of August toward noon I was about entering the seminary. The weather was fair and the sky was covered with small fleecy clouds. Just as I was about crossing the threshold of the establishment, I accidentally looked toward the south and saw a brilliant body that resembled a shooting star, or rather a piece of red hot iron, which was moving from east to west in a nearly horizontal or slightly inclined direction, toward the earth The meteor produced scarcely any more effect than a sky rocket, and I thought at first it really was one. Its flight was quite rapid and I followed it for two or three seconds over a space of a few degrees. It left in its wake a luminous train which, however, became very quickly extinguished. Perhaps this was simply a result of the persistence of luminous impressions upon the retina. This was not the case, however, with a nebulous band of whitish color that lasted about five minutes. Most of the meteorites of this beautiful meteor were certainly lost. Six only were collected, five at Oschansk and one at Tabor. In these two regions they were clearly seen by eyewitnesses to come into contact with the earth.

Mr. Nagibine was in one of the streets of Oschansk at the moment of the fall and heard the sound that announced it. About a half a minute after the noise ceased he saw a blackish stone fall that whistled through the air like a cannon ball. Several laborers ran and found the meteorite at the bottom of a hole about 20 inches in depth that it had made in the earth. It was as large as a child's head, and was still hot. It weighed about four pounds.

As regards Tabor, the story of the fall is furnished by two peasants who were working in a field. Suprised by the detonations, they raised their eyes and saw a shooting star of a dark red, followed by a white smoke agitated by the wind and diffusing an odor of sulphur (Fig. 4). The mass passed at about 200 yards above their heads, and, through its impact, raised a column of dust. One of the peasants, who was upon a stack of wheat, was thrown to the ground by the disturbance of the air. A hole 14 feet in depth and 7 feet in section was discovered at the point of the fall (Fig. 2). The stone was so hot that it could not be removed at once. The next day it was taken out in pieces, one weighing 220 pounds and the others from 205 to 25 pounds. There were about 180 pounds of debris, and the total weight of this single stone may be estimated at 720 pounds.

It results from the data furnished by the witnesses that the meteor moved from 10 to 15 degrees from the east toward the south, and that, from the point of observation in the field, the angle of falling appears to have been about 55 degrees on the horizon.

Still another stone fell into the Kama River and was not found. A forester witnessed the fall from the port of Ust-Nitrinsk. According to his story, the earth trembled at the impact, and the water of the river, after being raised in a high column, continued to seethe for a long time after the fall. Fifty or sixty horses that were drinking in the river at the same moment were knocked down by the concussion of the air. On putting together the fragments that fell at Tabor it was found that the stone had a polyhedral form, with very obtuse angles and sensibly plane faces. It everywhere presented the usual black crust, but, what is exceptional, the latter exhibited blisters of the size of a pea, and even larger. Its thickness permitted of its being removed in scales of from 2½ to 5 inches section. Fig. 1 shows the appearance of a specimen in the museum, and allows it to be seen that the stone is far from being the same in all its parts. We have made a very detailed chemical and microscopical study of it, and the principal conclusion of our work, the only one to be reproduced here, is that the Oschansk meteorite belongs to a brecciaform lithological type that we de-

FIG. 4.—PASSAGE OF THE METEORITE AT TABOR.

scribed twenty years ago under the name of *canellite*, and to which, among others, belong the meteorites of La Baffe (Vosges), September 13, 1842; of Assam (Indies) 1846; of Canellas (Spain) May 14, 1861; and of Feid-Chair (Algeria), August 16, 1876. It consists of juxtaposed fragments of two oolithic rocks, one of quite a dark violaceous color, called *limerickite*, and the other entirely white, and that we have named *montrejite*.

By its complex structure, the Oschansk meteorite contributes, in a very efficacious manner, to shed light upon the general history of stones falling from the sky. Without entering here into a subject whose broad lines were long ago laid out before our readers, we shall confine ourselves to remarking that the existence, now so often observed among meteorites, of breccia, that is to say, of masses resulting from the juxtaposition of rocks differing from one another, has permitted of our recognizing, in the space in which meteorites are formed, general geological conditions analogous to those that exist upon the earth.

The information of this kind now acquired constitutes as a whole a grand science, which under the name of comparative geology connects, without confounding, geology and physical astronomy—the science of the earth and the science of the heavens.—*S. Meunier, in La Nature.*

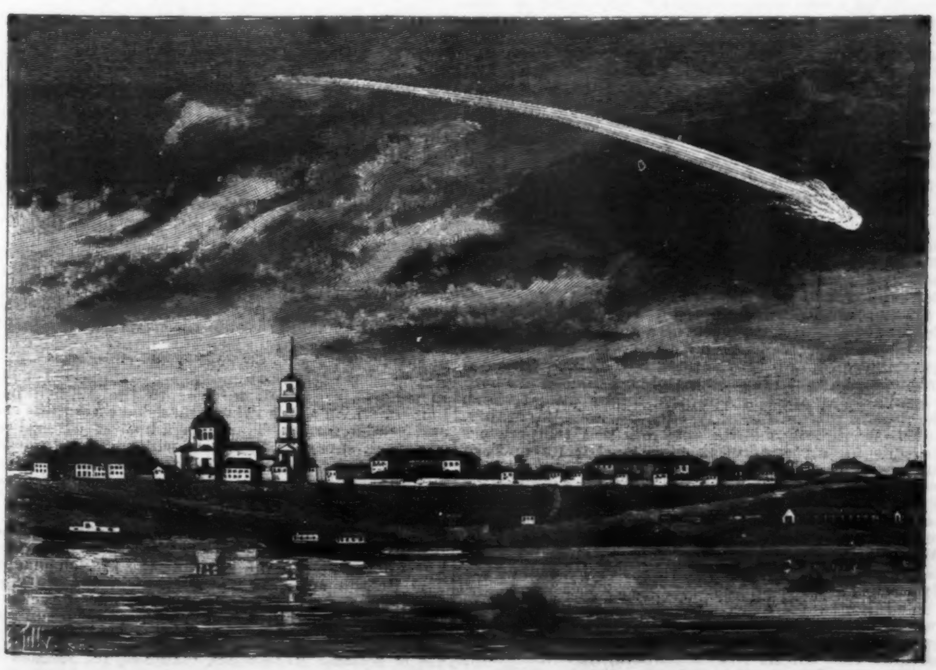


FIG. 3.—PASSAGE OF OSCHANSK METEORITE OVER PERM.

[NATURE.]

ON THE INCUBATION OF SNAKES' EGGS.*

MOST Reptilia are oviparous, but certain of the Lacertilians, and many Ophidians, especially vipers and sea snakes, are ovo-viviparous—that is to say, the eggs are hatched within the mother, or, as sometimes occurs, during the process of parturition. This is the case with the English viper.

There has not been much written on the hatching of snakes' eggs. Almost the first literature of the subject appears to be some observations of M. Valenciennes made in 1841, at the Jardin des Plantes, in Paris, and published in the *Comptes Rendus* on a python (*Python bivittatus*) which was about 10 feet long. This reptile, in the beginning of May, deposited fifteen eggs; it coiled itself up over them for fifty-six days, after which

*By Walter K. Sibley, M.B., B.C., B.A. Camb., Assistant Physician to the Northwest London Hospital. (Substance of a paper read before the Biological Section of the British Association, at Leeds, September, 1890.)

period eight of the eggs hatched, and the young snakes came out, each measuring about half a meter in length. With regard to the temperature of the mother, he says there was a marked increase of temperature during the whole period of incubation, which was highest at the commencement, and gradually diminished till the close.

In 1862, Sclater, in the Proceedings of the Zoological Society, described a python (*Python sebæ*) which incubated her eggs, one hundred in number, for eighty-two days, at which period they were removed, none having hatched, and on examination it was found that five or six contained embryos. With regard to the temperature, he states that, in every observation, the female was several degrees warmer than the male, both being kept under similar conditions. Double observations were always made, one with the thermometer placed on the surface of the body, and the other by placing it between the folds. The difference in the temperature of the snake's body and of the surrounding air was higher by from 2·8° to 12·4° F., taken on the surface of the animal, and from 6·8° to 20° F., taken between the folds of the skin.

In the same year Colonel Abbott recorded that he had in his possession in India a female boa, which incubated her eggs, forty-eight in number, for three months, at the end of which period, on opening one of the shells, a live fully-formed young one was found.

In 1880, Forbes carried on some investigations with the eggs of *Python molurus* in the Zoological Society's Gardens. The snake was some 12 ft. long, and on the night of June 5–6, deposited about twenty eggs, and then coiled herself around them, almost completely concealing them from view. She continued to cover the eggs for a period of six weeks, never eating during the whole time, and apparently only once leaving the eggs for a few hours one morning early in July.

On July 18—that is forty-three days after—the eggs revealing evidences of decomposition, they were removed, and one or two were found to contain embryos.

From June 14—that is, nine days after the eggs were laid—till they were removed on July 18, careful temperatures were taken every two or three days between the hours of 12 and 2 P.M. The temperature was taken both of the incubating female and also of the male, which was kept under similar circumstances in the next cage, the same methods being employed as in Sclater's experiments just described. The temperature was always found to be highest when that of the air in the cages was also highest. The temperature of the female was higher and more constant than that of the male. The greatest difference between that of the snake and that of the air was 8·3° F. for the male, and 9·6° F. for the female, taken on the surface; and 11·6° F. for the male, and 16·7° F. for the female, taken between the coils of the skin. It will be noticed that Valenciennes, who kept his snakes much colder,* records a difference of as much as 38·7° F. (21·5° C.), and some of his eggs hatched, which was not the case with Forbes'; also the later observer does not record a steady fall of the temperature throughout the incubation, as did the former.

The common English snake (*Natrix torquata*) lays its eggs, varying in number from about fifteen to thirty, principally in manure heaps, but also in holes and crevices between or under stones. It is usually stated they are laid in the autumn, but I have frequently found them toward the end of July, and one snake I had in confinement laid them as early as the 11th of that month. The shells being very thin and soft, they require very delicate handling, the eggs being readily injured.

When laid under stones or in crevices, they are protected from the immediate pressure of the earth, and when deposited in manure, which is much bound together by leaves and straw, etc., they are not individually subjected to much pressure. It must also be noticed that the eggs are usually found very close to the surface, and if laid deep in the manure heap, they, as a rule, do not hatch, although if examined late in the season the young snakes are found in them often completely formed, but dead. When first laid, the eggs are swollen out and full, and many or all the eggs are firmly bound together by adhesive medium. The egg shell, if examined with the microscope, is found to consist of peculiar glistening fibers arranged in many separate layers. Between the outer layers only a small quantity of calcareous matter is present, and these fibers appear to be closely fitted together. There are seen in fresh, or better in specimens hardened in chromic acid, ten or more layers laid very closely one upon the other. The outer layers differ from the others in that they contain many rather club-shaped bodies of very different thicknesses and appearances placed between the other fibers.

The eggs are at first of a whitish straw color. As time goes on, they become somewhat darker and then of a brown color, and finally very dark; but these color changes do not occur evenly over the whole shell, but in patches, and to a very varying extent. At the same time the regular outline is gradually lost, the shell shrivels, loses its original elasticity, and so at this stage impressions made upon the surface remain permanent. The diminution in actual bulk of the egg is probably due to evaporation of water from its substance. It is chiefly the extreme delicacy of the eggs, also the difficulty of keeping them in the requisite amount of moisture, that makes them so very hard to hatch artificially. But all these difficulties may with care be overcome, as I will proceed to describe.

On July 22, 1889, I found, in the manure of a cucumber frame in Surrey, some seventy snakes' eggs in two masses, close together, and probably deposited by at least two snakes. The eggs were apparently of recent date, but showed great difference in the stage of their development—even those which were clearly laid by the same female. After removing some eggs for immediate examination, the rest were covered up again by the manure and left.

On September 8 they were again uncovered, and some were removed and taken to London. One of the eggs being opened at this period, the embryo snake was fairly well formed, and movements were visible, but feeble. The eggs were brought to London on September 8, and on the 9th some were placed in an ordinary bacteriological incubator regulated for a temperature of 32° C. (89°·6 F.) The eggs were placed in open glass dishes with a small quantity of dung laid both at the bottom of the dish and also partially covering the eggs. Some of the dishes were left open, and others were protected by a piece of glass loosely laid over, but allowing the air to freely circulate, and were kept perpetually moist by cotton wool soaked in water. At the same time some eggs were placed under similar conditions in the atmosphere of the room, the temperature of which was maintained at about 17° C. (62°·6 F.) On September 17, the incubator leaked and had to be repaired, and during this period the eggs from it were left in the room temperature—namely, about 17° C.; the eggs being replaced in the incubator again on September 25.

On September 27, two of the eggs which had been kept all the time in the room temperature showed signs of hatching—that is, the heads of the young snakes had broken through the shells, temperature 19° C. (66°·2 F.) These were noticed at 10 p. m. The next morning at 10 a. m., the hatching eggs presented the same appearance—that is, the heads only were out of the shells. The dish with these eggs was then placed on the top of the incubator at about a temperature of 24° C. (75° F.) At 1 p. m. the condition was unchanged, and at 10 p. m. both snakes were quite out of their shells.

On the same day, that is, the 28th, at 10 p. m., the head of one of the snakes inside the incubator was seen; at 10 the next morning this snake was quite free from its shell.

During the next few days several more eggs hatched, both those inside and those outside the incubator.

Some eggs, which were kept in a tin of manure in the room atmosphere of about 18° C. (64°·4 F.) since September 8, were on the 25th placed outside the window. During the night the temperature registered a minimum of 1°·5 C. (35° F.) On the 26th, they were brought inside again, and on the 27th they were placed in a temperature of 26° C. (78°·8 F.) In the course of time some of these eggs hatched with the others. The eggs in the incubator were placed at first on their sides, but on the 28th some were placed on their ends, and in both positions they appeared to hatch equally well.

The period of incubation of the eggs was thus about seventy-five to ninety days; the python, as described by Valenciennes, being fifty-six days. It was noticed that many days often elapsed between the hatching of the eggs of the same lot—even those kept under similar circumstances. The differences in the actual stage of development of the eggs when first laid may possibly explain the apparent differences in the dates of hatching.

On July 11, 1890, a snake I had in confinement laid eighteen eggs. Some of these were placed at a temperature of 16°–20° C. (61°–68° F.) At the end of October, not being hatched, they were opened, and found to contain fully-formed young ones, but these were all dead. Other eggs from the same lot, which was laid on July 11, were sent into the country and placed in a manure heap: on September 9, an egg being opened, the embryo snake was nearly formed, but there were no movements visible; on September 24 these eggs began to hatch—that is, after an incubation of seventy-five days.

From the first set of experiments it did not appear that the actual temperature influences to any great degree the period of incubation, or at least not after the first few weeks. (In the cases described it would appear that the eggs had been deposited some seven weeks before they were removed, and then kept artificially from three weeks to a month before they hatched.) Also, that exposure to the atmosphere does not destroy their vitality, provided they are kept fairly moist, some having hatched after several days' full exposure to the air of the room; and that they may be exposed to rather low temperatures, at least for a few hours, and yet finally hatch. As might be expected, some eggs which were placed in small glass pots and hermetically sealed did not hatch.

The process of hatching was very interesting to watch. At first a slit appeared in the uppermost part of the egg, whether the egg was placed on the side or on one end; most usually the slit rapidly became a V-shaped one, which in shape and position corresponded to the snout of the young reptile—that is to say, the apex of the V corresponding to the tip of the lower jaw. The snakes would often remain for some hours in this position, with just their snouts out, and, when disturbed, would withdraw these into the shells again. In a state of nature I have seen them, when completely out of the shell, retreat into it again when disturbed. When first out of the shell, the young snakes were very smooth and velvety to the touch; there was usually some opacity about the cornea, which disappeared after a few hours; the yellow ring on the neck was well marked from the very first. They were about 15 cm. (6 inches) in length, and weighed about 3 grammes (45 grains); the eggs themselves weighed about 6 grammes (80 to 90 grains). One cast its skin within a few days after birth, and died. Occasionally they were hatched with the yolk-sac adherent, and in these instances always died. From the first the snakes were very lively, and within a very few days produced the characteristic hissing noise when provoked.

Many problems in connection with the subject of the incubation of eggs might be mentioned. It would be interesting to ascertain definitely what are the maximum and minimum temperatures at which the vital processes can take place in an incubating egg. There is probably an optimal temperature, or one at which the process proceeds most rapidly or most favorably. So also it might be asked, Is the optimal temperature the same for all kinds of eggs—those, for instance, of various forms of birds and those of snakes and lizards? Is the increase of temperature, both of the incubating bird and of the incubating python, essential to the hatching of the eggs? What is the reason of the differences in the incubation periods between different birds? Why, for instance, do pigeons' eggs hatch in fourteen days, hens' three weeks, turkeys' a month, and swans' six weeks?

We know that if a hen's egg be maintained for some twenty-one days at a temperature of about 40° C. it will hatch; but I am not aware of any experiments to ascertain if they will hatch at a temperature considerably under or much over this; and what is the minimum temperature at which they will hatch at all? In the case of many of the micro-organisms, bacteriologists have found the actual limits of temperature within which the various species grow, and also that most of them have an optimal temperature—that is, one at which these lowest forms of vegetable life grow most luxuriantly.

Literature.—Valenciennes, *Comptes Rendus de l'Académie des Sciences*, 1841; Sclater, Proceedings of the Zoological Society, London, 1862; Abbott, Proceedings of the Zoological Society, London, 1862; Lataste Fernand, Paris, 1877; Forbes, Proceedings of the Zoological Society, London, 1880; Fisher, *Der Zoolog. Garten*, Bd. 26, 1886.

* The extreme temperatures of the air recorded by Valenciennes, who took his observations when the cages were coldest, *i. e.*, before the fresh hot water was put in, were 17° and 23° C. (62·6° and 73·4° F.) respectively. The temperature of the two cages in which the animals were kept was only on three occasions less than the highest in Valenciennes' series.

[Continued from SUPPLEMENT, No. 785, page 12539.]

THE OUTLOOK FOR APPLIED ENTOMOLOGY.*

METHOD OF USING BISULPHIDE OF CARBON AGAINST GRAIN WEEVILS.

THE use of bisulphide of carbon against different insects attacking stored grain has greatly increased in this country since I first recommended it some thirteen years ago.† There is, however, considerable diversity in the methods of using it, and the recommendations of some of our writers have evidently been made with no sense of the fact that the fumes are heavier than the air and descend rather than ascend. Prof. A. H. Church in a recent number of the *Kew Bulletin* records that he found that 1½ pounds of the bisulphide is enough to each ton of grain. He advises that it be applied in the following way:

A ball of tow is tied to a stick of such a length that it can reach the middle of the vessel containing the grain. The tow receives the charge of bisulphide, like a sponge, and is then at once plunged into the vessel and left there, the mouth of the vessel then being tightly closed. When necessary, the stick may be withdrawn and the charge (of 1 ounce to 100 pounds) may be renewed.

The action of carbon bisulphide lasts in ordinary cases six weeks, after which period a fresh charge is required. The bisulphide does no harm to the grain as regards its color, smell, or cooking properties, and the germinating power of most seeds is not appreciably affected, provided that not too much is used, nor its action continued for too long a period.

The Assistant Director of Agriculture of Burma is reported to have used naphthaline instead of bisulphide in the following way, but I should not expect anything like as good results from the naphthaline as from the bisulphide:

A hollow bamboo cylinder 1½ inches in diameter, with a stick fitted into the cavity, is pushed down to the bottom of the bin, the stick is then withdrawn and a few teaspoonfuls of naphthaline powder are poured into the bamboo, which is then drawn out, leaving the naphthaline at the bottom of the bin. If the bins are very large, this should be done once to every ten feet square, and the application should be repeated every fifteen or twenty days.

INSECTICIDE MACHINERY.

A profitable hour might be devoted to the subject of insecticide machinery, but I must content myself with a few words. At a trial of such machinery at the Mareil-Marly vineyards during the late Paris Exposition I had an excellent opportunity of witnessing the latest advances made in France in this direction, and it was extremely gratifying to note that, with whatever modifications of the power employed (and many of the machines were very ingenious) all other forms of spraying tip had been abandoned for vineyard purposes in favor of modifications of the Riley or Cyclone nozzle. The superiority for most practical purposes of the portable knapsack pumps of V. Vermorel, of Villefranche (Rhone), France, was sufficiently evident. M. Vermorel has identified himself with the regeneration and improvement of French grape culture in many directions, and is, withal, an enthusiastic student of insect life. I spent a very profitable day with him last year both at the factory and at his home, where he has established a virtual experiment station in the midst of a fine vineyard on American roots, and with every facility for various fields of investigation, none of which is deemed more important than the work in entomology, for he fully realizes how much there is yet to learn of some of the commonest insects destructive to the vine, even in an old country like France. But in no direction has he accomplished as much good as in his work with insecticide and fungicide machinery. His sprayer, with independent pump, his diaphragm pump—l'Eclair—and his reservoir with suction and force pump are all admirably adapted for the purpose they were invented for, and may be obtained in France at a cost of from $5 to $7, which is tripled before reaching this country, thanks to our present tariff system.

The Galloway Sprayer.—The last number of the *Journal of Mycology*, the serial publication of the Division of Vegetable Pathology of the Department of Agriculture, gives full description with figures of a knapsack spraying apparatus, for which the special merit claimed is cheapness.

The combination of a suction and a force pump with knapsack reservoir has been frequently made in France as illustrated by the apparatus styled the "Cyclone" of Vermorel, the Japy, Vigeroux, Nouges, and Perrin sprayers, and the sprayer of the society "L'Avenir Viticole." A number of pumps manufactured in this country of this style were mentioned or described in the Fourth Report of the U. S. Entomological Commission. These, in general, are much inferior to the French pumps named, which are, however, modeled after those earlier and cruder forms. There are a host of other French knapsack spraying machines which differ from those mentioned, by propelling the liquid by means either of air pumps, diaphragm pumps or devices in which the pump is attached to the reservoir by means of a rubber hose.

In 1888, Mr. Adam Weaber, of Vineland, N. J., brought out the Eureka sprayer, a very serviceable knapsack pump modeled after the French machines. The French sprayers will cost, including duty, shipping, etc., from $18 to $25; the Weaber sprayer is sold for $21, which is but little more than the cost of manu-

* Address of Dr. C. V. Riley at the annual meeting of the Association of Economic Entomologists, Champaign, Ill., November 11 to 14, 1890.

† *Farmers' Review* (Chicago), March, 1879.

facture. Prof. Galloway's machine is sold for $14, or from one-quarter to one-third less than the Weaber or the French sprayers.

In the first announcement of this pump in No. 1, Vol. 6, of the publication cited, and in the later full description, no statement is made of the indebtedness of the inventor to these older machines, except in the case of the original description of the lance and nozzle (*op. cit.* Vol. 5, No. 2), where credit is given. This naturally gives the impression that the apparatus is novel in many or all its features.

When compared with the French machines, the following facts become apparent:

1. The reservoir is practically identical with that of the Vermorel, Japy, and other French machines, and the opening for introducing the liquid with strainer and lid presents no new features.

2. The pump is an ordinary double cylinder (or hollow piston) force pump, the hollow piston furnishing an air chamber which causes the liquid to be forced out in a continuous stream.

3. The lance and nozzle combination consists of the Riley nozzle fitted to a lance and provided with a degorging apparatus, which also acts as a stop cock modeled exactly after Raveneau's apparatus, and is practically the same as the Japy degorger and stop cock, except that the action is reversed. In the latter (see "Insect Life," Vol. 1, p. 265, Fig. 61) the spring normally closes the discharge orifice, and in the former the orifice is normally open and is closed by the action of a lever in the spring.

That this modification of the foreign knapsack sprayers will prove a serviceable one for vineyard work, and by reason of its cheapness and availability come into general use, I have little doubt.

STRAWSON'S AIR POWER DISTRIBUTOR.

A new and distinct type of insecticide machine, the invention of Mr. G. F. Strawson, Newbury, Berks, England, has attracted no little attention, and has received numerous awards during the past two years at various agricultural shows in England, and has been very favorably noticed and recommended by competent judges. It was shown at the late Paris Exposition and was thoroughly tested before a select jury, from which it received the highest praise and was awarded a gold medal. I had occasion to study it thoroughly, not only at Paris, but at the Royal Show at Windsor, and am under obligations to the inventor for courtesies and facilities afforded.

It will have, in common with all the heavier and more expensive machines, to contend with the more popular and less expensive portable machines. It has many advantages in the control of the volume and character of what it disseminates; and with some modifications and adaptations for nether spraying, it would prove extremely serviceable in extensive fields of any crop that needs such spray, and where the rows are relatively straight and the plants low. The principle also is a good one and practicable, with modifications, to many other uses.

The machine is called the "Strawsonizer," and is a pneumatic or air blast distributor, and may be adapted to a variety of uses, such as broadcast sowing of grains, distribution of fertilizers or of disinfectants in cities, and of dry or liquid insecticides.

The machine is light, simple in construction, and easily operated by one man—the larger sizes being drawn by one horse and the smaller by hand power. It is constructed largely of wood, and is mounted on two iron wheels. The distributing power is obtained by a blast of air produced by a revolving fan worked by the traveling wheels of the machine.

The essential part consists of a suitable receptacle or hopper either for liquid or dry substances from which the material is fed automatically and regularly to the blast generated by the revolving fan, the whole operated by suitable gearing. A receptacle for either dry or liquid material can be employed in connection with suitable nozzles or deflecting devices on all the machines, so that with practically one apparatus all the kinds of work indicated above can be accomplished.

For solids a metal spreader is used, while for liquids, nozzles of the direct discharge type but variously arranged to suit different requirements are employed.

Very uniform and rapid work may be done with this machine in broadcast sowing of wheat, oats and smaller seeds. These are distributed with great regularity over a track 18 to 20 feet wide, giving a rate of 30 to 40 acres per day. It is especially serviceable as a distributor of fertilizers (phosphates, nitrate of soda, lime, etc.) and all insecticide powders, which latter may frequently be applied in connection with the former substances.

Liquid insecticides are distributed broadcast at a rate of from one gallon upward per acre, and by the action of the powerful blast of air are broken up into a fine mist which spreads uniformly to a width of 20 ft. Nozzles for upright or lateral spraying would adapt the machine for work in hop fields or orchards.

A patent for the apparatus has recently been taken out in this country, but its manufacture here has not so far been inaugurated.

The one horse power machine for broadcasting grains, fertilizers and either solid or liquid insecticides, with suitable receptacles and nozzles, is retailed in England for £30 sterling or $150. If fitted with special nozzles for vertical work, £2 extra is charged. Hand power machines are sold for £12 and £14. These prices would be even greater in this country and would doubtless interfere with its adoption, were it not that it combines the other advantages indicated.

ABROAD.

With the constantly increasing facilities for intercommunication between different parts of the globe the results obtained and experiences had in one part are soon available for the rest of the world. Thus France has more than repaid the United States for the good—however vast and important—that has resulted to her by the use of American resistent stocks. Her experience with these American vines has reacted beneficially upon our own viticulture in many directions, but particularly in the great advance which her sons have made in insecticides and fungicides and in convenient, portable insecticide and fungicide appliances. It has often been said of the French that they are not an originating people; however that may be, they are very quick at adopting and improving ideas and discoveries once brought to their notice, and no nation is more appreciative of the immense practical benefits to be received by the adoption of the most scientific methods. In fact, no nation has given greater government incentive to the pursuit of science in its bearings upon the welfare of mankind, and we may study with profit what she has of late years done in our own line.

I had a delightful visit last August from Mr. John West, who came to this country as a delegate from Victoria, to ascertain all he could of our methods, also from W. W. Calton Garby, of Adelaide, who visited this country in a similar capacity. Economic entomology in his section of the world is extremely interesting to us; for while the seasons are reversed, as compared with ours, many of the same injurious insects occur in both countries. Thus I was glad to get perfect confirmation from Mr. West of the fact that the Northern Spy and the Winter Majetin are found to protect the apples grafted upon them from the woolly aphis. A great deal has been published of late years in the New Zealand and Australian papers on "blight proof" apple stock, and they have had an important experience, the outcome of sore necessity, for *Schizoneura lanigera* has there been one of the most serious drawbacks to apple culture.

There can be no question but that this experience will prove of value to our apple growers wherever these varieties succeed and the woolly aphis abounds. The use, as stocks, of such varieties as enjoy immunity from the woolly aphis has occurred to our own people, but no such extended experience has been had in regard to any particular resistent variety. Some of our injurious insects are often worse in Australia than they are with us, and we may expect to reap the benefit of the experience had there with regard to them. This will doubtless be true not only of the codling moth, but of their peach aphis, which, from all that I can learn, is substantially the same species as that which does so much damage in our lighter soils along the Atlantic coast, and which Dr. Erwin F. Smith, of the division of mycology of the department at Washington, has carefully studied lately and described in great detail as a new species under the name of *Aphis persicæ-niger*, but which I have reason to believe is the *Aphis prunicola* of Kaltenbach.

The Italians have been making a very interesting fight against an insect which has threatened their very important and extensive silk industry, by its attacks upon the mulberry tree. This insect was described by Targoni Tozzetti in 1885 as *Diaspis pentagona*. It occurs upon a number of different trees, among them the paper mulberry, the spindle tree, the peach, the cherry laurel and certain willows, as well as upon the cultivated white mulberry, and it would seem that its taste for the latter tree is one recently acquired, judging from the late date at which the habit has attracted attention. The energetic director of the entomological experiment station at Florence investigated the species in 1886 and recommended the use of mechanical means at the time of hatching of the young, viz., the scrubbing of the trunks and larger branches with stiff brushes and a subsequent application of a mixture of soap and water with 4 or 5 per cent. of kerosene.

Prof. Franceschini, the editor of the *Rivista de Bachicoltura*, recommended the adoption of the Balbiani formula as used against phylloxera, and consisting of crude tar oil, naphthaline, quicklime, and water, the naphthaline being dissolved in the tar oil and the water and lime afterward added together. The insect appeared first in several cantons of the province of Como and speedily spread to the adjoining localities. The matter was brought to the attention of the Ministry of Agriculture, and a commission was appointed consisting of Prof. Targoni Tozzetti, Dr. Alpe and Dr. Andres, who immediately familiarized themselves with the methods in use in this country, and have made extensive experiments with our kerosene emulsion, with our fumigating processes and with other new remedies. The subject has been taken in hand with great vigor and the government has interested itself to the extent of appointing inspectors in the different communes in the infested territory and establishing regulations which oblige the immediate report of new localities and the adoption of measures of extinction when ordered by inspectors. These regulations also provide that the inspectors must do the work at the expense of proprietors when the latter refuse to do so; they prohibit the exportation of leaves from infested localities to others, and provide for indemnity to owners for the destruction of trees when the degree of infection is such as not to threaten the ultimate life of the trees. Expense for experiments of all kinds and for the watching and care exercised by agents are borne by the state, while the expense for the execution of certain of the regulations are borne one-third by the proprietor and two-thirds by the local society. A fine for disobedience of the regulations is also provided for. The laws, as published, are none too severe and meet the urgency of the case, and it is refreshing to notice the energy with which the government has met the threatened danger, and at the same time gratifying to note the appreciation shown of our own means and methods.

USE OF CONTAGIOUS GERMS.

Most of you are aware that I have not had the greatest faith in the availability of contagious disease germs as a means of battling with injurious insects in field, garden, orchard or forest. There are so many delicate questions involved and so many obstacles in the way of practically carrying out any plan, however plausible theoretically or true in principle. Our ability to contaminate healthy by diseased specimens is but a short step, and leaves many important questions, as of rapid dissemination, untouched. The theory is very tempting and has been particularly dwelt upon by some who were essentially closet workers, having but faint realization of the practical necessities of the case. Theoretically, with those insect diseases of a cryptogamic nature, having a complex life-history and a resting spore, the difficulties are greater than with those of a bacterial origin, and it is to these last that we should look for important aid, if it be available. Yet if the work of Messrs. Lugger and Snow should be fully substantiated, the best results have so far been obtained with the entomopthora of the chinch bug. No one will be more pleased to have his doubts dissipated by some tangible evidence of the practicability of this method than myself. Success, if possible, will come only by investigation upon thoroughly careful and scientific lines, such as those begun and still pursued by Prof. Forbes. The ease with which he conveyed the silkworm *flâcherie*, to other larvæ, his conveying the cabbage worm micrococcus to other larvæ, and his carrying this micrococcus in cultures over winter are promising facts, as is also Prof. Osborn's contaminating cabbage worms in Iowa with specimens brought from Illinois. Congress having at its last session appropriated $2,500 for some further investigation of the boll worm, the possibilities in this direction for this particular insect have caused me to plan investigations having for their object thorough field experiment with some of these disease germs.

Heliothis armigera is one of those cosmopolitan insects which has become more injurious in the United States than in any other part of the world, by virtue of its partiality for green corn, green cotton bolls and green tomatoes. The polyphagous and partially endophytous habit of the larva render its destruction difficult except during the earlier free-living stages by the fine spraying of the arsenites on the under surface of the leaves.

The ideal treatment for the larger burrowing worms was some rapidly spreading disease germ that would penetrate and destroy them in their hidden recesses. The insect was reported as extremely abundant in cotton bolls during the summer, especially in Texas; but by the time the appropriations became available, its numbers had decreased, and it was too late in the season to do much more than prepare for next year. We may expect, as a result of special investigation, much additional fact and experience both as to habits, natural enemies and means of controlling; but it is my desire to make the trial of these disease germs the special feature of the investigation. Of those employed in the investigation, Mr. F. W. Mally was a former assistant to Prof. Forbes and has some experience in the study and culture of disease germs, while Dr. A. R. Booth is something of an enthusiast on the subject and has already established the susceptibility through contact of the boll worm to the cabbage worm micrococcus (*M. pieridis*) of Burrill, and is preparing to carry the germs through the winter. I have had in mind, as probably the most promising germ, that which affects *Nephelodes violans* in a similar epidemic way, but which, as Prof. Forbes informs me, is a quite distinct micrococcus, and shall be pleased to have any of you co-operate with me next year, by informing me of any disease of this character that may prevail in your several localities.

APICULTURE.

While little attention has so far been given by the different stations to the subject of apiculture, except at Lansing, it is nevertheless an important branch of economic entomology, and there is much promise of good results yet to come from careful experiment and investigation. One of the most inviting fields is the search for and introduction of new varieties or species of bees, for just as American apiculture has profited in the past by the importation of races like the Italians, Syrians and Carniolans, there is every prospect of further improvement by the study and introduction of such promising races as are either known to occur or may be found in parts of Africa and Asia. *Apis dorsata* is believed to have many desirable qualities, and private efforts have already been made to introduce it and have failed chiefly for want of means. The further study of desirable bee forage plants and the introduction and acclimation of such as are known to be valuable in parts of the country where they do not yet occur are very desirable.

Much has yet to be done also in the line of systematic breeding, and we should be able to make rapid advances in the amelioration of existing races by proper selection, if we could assume practical and ready control of the fertilization of the queen. In these directions we are now planning at the department some effective work, but the introduction of foreign bees, which the department should be able to undertake to better advantage than any private individual or State institution, is rendered more difficult by virtue of the restrictions in the appropriation already alluded to in discussing the subject of the introduction of parasites, and whatever is done in the other directions by the national department will be done most advantageously through the co-operation of one more of the State stations, many of which are far better equipped and are more favorably situated for apicultural work than the department at Washington.

SILK CULTURE.

This, again, is an important part of applied entomology, and, as most of you know, I have for many years worked toward the establishment of silk culture in this country. The result of these efforts has served only to convince me of the utter impossibility of successfully entering upon the enterprise on a business basis, without protective duty on the reeled or misnamed "raw" silk. Some five years ago, largely through the then commissioner's appeal, based on my own report and assurances, Congress appropriated $15,000 for the express purpose of giving a thorough test to the Serrell automatic reeling machinery, in the hope that by its means the question of labor might be minimized and we could reel silk at a profit. The previous attempts of the department, which it had been my lot to direct, of establishing such reeling or market centers at San Francisco, New Orleans and Philadelphia, had proved unsuccessful, and the promise was made to Congress that two years of experimentation under my immediate direction at Washington would enable a definite decision of the question. Two years passed and the appropriation was increased and continued a third year, for various reasons stated at the time. At the end of the third year, I became convinced of the futility of continuing the experiments indicated without protective duty, and so stated in my report. While in Europe in 1889, I paid particular attention to the question and visited the Serrell works at the Serrell establishment at Chabeuil, where I found that Mr. Serrell had abandoned his own reeling machinery, which was stored in the cellar, and had gone back to the use of the ordinary non-automatic reeling machines, though employing improved automatic brushers and cleaners of his own invention, which have such advantages that they are fast coming into use in France and Italy. I felt more convinced than ever of the futility of continuing the experiments at Washington, except with the protection indicated, especially as any improvement or valuable outcome of such experiments would redound primarily to the benefit of a private corporation, and

doubtless benefit other countries more than our own. The hope of improvement and the attractiveness of the machinery to the average visitor, among other reasons to which I need not now refer, have caused continuation of the special reeling work against my advice. From the foregoing you will naturally draw the conclusion that I do not at present favor any time being wasted on the subject at the State stations, since Congress declined to put a duty on "raw" silk.

(*To be continued.*)

OUR TWENTY "BEST" APPLES.

THE American Pomological Society's list of apples contains but twenty native sorts to the names of which are affixed the letter "b," indicating that, in the judgment of the society, or of such of its membership as were present in the meetings where the quality of apples was under discussion, these alone are entitled to rank, as to dessert quality, above all other apples native to this continent. This list contains no sweet apples. As to season, four are summer, three early to late fall, and thirteen are winter varieties. In origin seven are from New York, three from Massachusetts, two from Connecticut, one from Pennsylvania, six Eastern, with State unknown, and one probably from Ohio.

May it not be permissible and profitable to review this list with an eye to its amendment, and perhaps its increase, at some future meeting of our society? May it not be true that in other States, from a wider range of country, there are apples deserving a place in this roll of honor? Perhaps a majority of the society might favor dropping the names of a few which have ceased to be planted from cultural defects or because they are superseded by more desirable sorts. Mere high quality, or local preference, without other merit, ought not to admit to a select fruit list indorsed by a continental society of practical fruit growers.

The word "best" should not be made too narrow in its application here. The quality being the same, or equal, other merits ought, I think, to be taken into consideration. Beauty must not be entirely ignored. Adaptation to general or a wide range of cultivation is worth considering. Health and productiveness of tree are important considerations. Not that these should admit, but that the lack of them may exclude an apple which, considered merely on its flavor, would be a proper candidate. I think we may take Pomme Grise, for instance, as an apple of so few other merits that its excellent quality alone should not give it a place.

American Summer Pearmain.—This fine apple, tracing its descent to an equally popular, but really inferior, English apple, is well entitled to its place. It has beauty, medium size, and a fairly productive and healthy tree, requiring high culture, however, to develop the merits of the fruit.

Belmont.—From all points here is a first rate apple, of good size, great beauty, a healthy and productive tree, with a crisp, delicate, and most agreeable fruit. Its season extends beyond the holidays.

Bethlehemite.—Like the preceding, this apple is of unknown origin, and the excellence of both was first widely recognized in Ohio, this being named for an Ohio town, as Belmont is for an Ohio county. Downing thinks it plainly a seedling of Newtown Spitzenberg, which it much resembles. The tree is a good grower and productive, while the fruit, of medium size, is well formed and well colored. The flesh is juicy, rich, mild, and aromatic. An all winter apple.

Bullock's Pippin is the oldest American Golden Russet, also locally known as Sheep's-nose, as mall, plain-looking apple, but of a most remarkable pear-like flavor. The flesh is yellow, tender, juicy, spicy, and rich. Early winter. It does not always ripen up perfectly, and the tree is subject to disease. Perhaps this variety might be dropped from the "b" list, along with Pomme Grise, which seems to be a close relative.

Cogswell.—Here is an old Connecticut fruit, and to it are assigned by the books almost every merit—a vigorous, productive tree, fruit of a size above medium, regular in form and size; a rich yellow color, well marked with red; fine grained yellow flesh, tender, rich, juicy, aromatic, and a good keeper. Why is not such an apple more often found in the general market?

Early Joe.—A well known little August apple, which is often seen in market and deserves its place. Yellow, with red striping; flesh white, tender, juicy, vinous. A general favorite.

Esopus Spitzenberg.—Downing says this Spitzenberg is considered by good judges equal to the Newtown Pippin; but our society excludes the latter from a list where the former stands prominent. "Flesh rather firm," says Downing, and it is all of that. In fact, it is a hard apple that never softens until it decays, and its high flavor alone gives it a place here. It is really a "best" pie apple. Unfortunately, the tree is not vigorous, and it is usually an unprofitable apple to grow for market.

Fall Wine.—This fruit is so subject to disease as to be not worth growing, except perhaps in a few localities, and I think it should be dropped, although a fine apple and the nearest to a sweet one that appears on this list.

Garden Royal.—Here is my favorite, and yet it must be said of it that it is strictly a garden apple, and worth growing only on the condition of high culture. It is of seaside origin, and I have never seen it thriving so well as within the range of New England's fog banks. The tree is healthy and productive, and with the high culture it requires I do not see why it may not be grown profitably from Portland, Maine, around to New York City. Wherever it can be well grown there is money in it. Season, August and September.

Melon.—A New York apple of good size, yellow, handsomely striped and shaded with red. Tree a moderate grower, and usually a good bearer. The fruit is of full medium size, often ribbed, but not prominently. Flesh white, tender, juicy, sub-acid, vinous. It bears handling poorly, but carefully packed it can be sent short distances in good order.

Mother.—Another apple of the Massachusetts coast which grows nowhere else so well. Smallish, conic, red. Flesh yellow, tender, rich, sub-acid. Rarely seen in market, yet common in private grounds and highly esteemed.

Northern Spy.—It is difficult for me to understand why the Spy is taken and King of Tompkins left off this list. In quality the Spy varies greatly, and at its very best is better than the King; but not as usually seen in the market.

Porter.—This is the favorite fall apple of Massachusetts and when well grown its quality is certainly very good. It has, however, been to a great extent superseded by the Gravenstein, and growers call it an unprofitable apple in competition with that variety.

Primate.—There is no better late fall and early autumn apple than the Primate, and it is easily grown.

Red Canada.—It is hard to find fault with the old "None-such," and they still grow it large and fair in some parts of Michigan. But it is an apple very apt to "go back" on the planter. In New England and generally in the East it is a sad failure.

Spitzenberg.—This (Newtown) Spitzenberg is much more to my taste than its brother of Esopus. The tree is more healthy and productive in the long run, and the fruit is not only rich, spicy, and vinous, but it is tender and crisp.

Summer Rose.—Here is a nice little apple, not much larger than the Lady Apple, and quite as good in its season, but no more worthy a place in a select list.

Swaar.—A noble apple truly, as Downing calls it. No one will object to the Swaar; but few have the soil to grow it in perfection. It ought not, therefore, to be recommended for general cultivation.

Wagener.—A good tree and a choice apple, provided the fruit is severely thinned. It is only so that it can be entitled to the place assigned it. As usually grown it is unprofitable and its high quality much obscured.

Let me conclude shortly with the query, Whether the time has not come to revise, prune and possibly somewhat to enlarge this list of America's "best" apples? —*T. H. Hoskins, Newport, Vt., Garden and Forest.*

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.